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Essays on International Trade and Financial Developmen

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DISSERTATION

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

DOCTOR OF PHILOSOPHY

THE UNIVERSITY OF TEXAS AT AUSTIN

May 2011

Dedicated to my parents.

Acknowledgments

I wish to express my deep gratitude to Dean Corbae for his guidance and benevolence throughout my study at the department of economics. Also my thanks goes to my committee members for their comments, suggestions and invaluable support. Special thanks to Ms Vivian Goldman Leffler for her patience and kindness.

I am indebted and grateful to my beloved family for their understanding, endless love and support throughout the duration of my studies.

Essays on International Trade and Financial Developmen

Publication No. _____

Faezeh Raei, Ph.D.
The University of Texas at Austin, 2011

Supervisor: P. Dean Corbae

The first chapter studies the effects of financial obstacles to productivity improvement in the context of trade reforms, by constructing a dynamic heterogeneous firms model with financial frictions. Trade reforms are considered beneficial because they confront the liberalized country's firms with more competition from abroad and increase their incentives to become more efficient. This implies that if poor countries do not improve their productivities they might lose the intended gains from liberalization. Financial frictions however have been quoted an important obstacle for firms to improve their productivities. To address these issues, first, using data on 15 trade liberalization episodes, I document that more financially developed countries experienced more productivity growth after their trade liberalization. Second, I construct a dynamic heterogeneous firms model with financial frictions in financing costs for productivity improvement. Calibrated numerical exercises

show that if a country does not improve its financial intermediaries at the outset of trade liberalization it may lose as much as %40 of potential output gains and productivity improvements. The result has policy implications regarding the simultaneous reforms in trade and financial intermediaries.

The second chapter is a cross country empirical analysis aiming to provide evidence for the effects of trade openness and financial development on firms decision to upgrade their technology and the impact on the distribution of firm size across countries. The idea is that reduction of trade barriers is likely to affect incentives of bigger firms to grow to export markets as well as incentives of smaller firms to innovate due to increased competition. Financial frictions, however are likely to limit the scope of these decisions and more so for smaller firms and capital intensive industries. This is likely to have heterogeneous effects on firms leading to changes in firm size distribution. I hypothesize that a combination of trade openness and low financial development increases the relative size of big to smaller firms. To test this hypothesis, I take advantage of cross country/industry differences in trade protection and financial development/needs to provide enough variation for identifying these effects. Using establishment level data from OECD countries, I provide evidence for this hypothesis, by performing double difference estimations. In addition using firm level data on 20,000 firms from World Bank's enterprise survey, I provide more evidence that trade openness promotes productivity growth particularly for bigger firms in less financially developed countries. The finding contributes to the literature on importance of finance for firm growth by focusing on the

channel of heightened competition due to trade. It highlights the importance of incorporating financial aspects of a country in trade analysis.

The third chapter is an exercise exploring the welfare gains of trade in a North-South trade where counties are asymmetric in their ability to produce more sophisticated goods. The exercise is based on the model by Matsuyama (JPE 2000), where the world is a static Ricardian model with a continuum of goods and unit demand non-homothetic preferences. One country (the south) has comparative advantage in production of goods with lower income elasticity of demand. As a result, over time with uniform global improvement in technology in the form of smaller unit labor requirements, the terms of trade moves against south. The numerical exercise, calibrates stochastic interpretation of the model to for a specific choice of countries and provides evidence that over time, if the patterns of specializations are not changed drastically, the country specialized in production of less sophisticated goods disproportionately grows less than the other one and has the terms of trade moving against it.

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Chapter 1

Productivity Upgrade, Financial Frictions and International Trade

This paper studies the effects of financial obstacles to productivity improvement in the context of trade reforms by constructing a dynamic heterogeneous firms model with financial frictions. It is widely argued that trade liberalization benefits countries by reallocation of resources towards sectors in which the country has a comparative advantage. This implies that if poor countries do not improve their productivities in tradable sectors they might lose the intended gains from liberalization. Financial frictions, however, have been identified as an important obstacle for firms to improve their productivities. To address these issues, first, using data on 15 trade liberalization episodes, I document that countries with higher level of financial development have experienced higher productivity growth after trade liberalization. Second, to quantify the importance of financial development, I construct a dynamic heterogeneous firms model with frictions in financing productivity improvement. Calibrated numerical exercises show that if a country does not improve its financial intermediaries at the outset of trade liberalization it loses 40% of its potential output gains. This finding has policy implications for simultaneous reforms in trade and financial sector.

1.1 Introduction

Trade reforms are considered beneficial because they confront the liberalized country's firms with more competition from abroad and increase their incentives to become more efficient. Numerous studies show that trade reforms have different effects across heterogeneous firms within each industry. While more productive firms self select to export and earn more profits, less productive ones might lose business to the increased competition. This is the typical channel through which trade reforms increase sectoral productivity by moving away business from less to more productive firms. A less studied channel, which is the focus of this paper, is that trade reforms increase the option value of innovation. The anticipation of trade reform increases the incentives of less productive firms to invest in their productivity to survive the increased competition. It is also likely to affect the incentives of bigger firms to become more productive in order to reap gains from the opportunity of access to bigger markets. It is thus important to study the firms decision to innovate at the outset of trade reforms when they are particularly likely to make such decisions[1].

Financial obstacles, however, limit the scope of firms' decisions to innovate, invest in their productivity, buy new machinery, undertake research and development and a host of other activities to grow (Levine 2004). While

[1]A new and growing literature focuses on the importance of joint decision of firms to export and innovate (see Bustos (2006), Verhoogen (2006), Trefler (2004), Costantini and Melitz (2007)).

financial and legal institutions of a country affect the overall availability and ease of obtaining finance, usually smaller firms are more likely to be more constrained than larger firms (Beck et al 2005). Financial development affects the key aspects of firm investment decision and consequently the aggregate industry growth and productivity. It is thus, particularly crucial in a trade reform because it directly affects the possibility of productivity improvement, a goal intended by trade reforms.

This paper has two contributions. First, I document that in countries with higher financial development, trade reforms brought about more productivity growth. I employ UNIDO (United Nations Industrial Development Organization) sectoral level data on 16 trade liberalization episodes between 1976 and 2000 to compare before and after changes in productivity growth. My empirical analysis shows that countries that had better financial intermediaries, such as New Zealand, Spain, Hungry and Uruguay, at the outset of their trade reforms experienced higher productivity growth compared to the less financially developed countries, such as Mexico and Sri Lanka. These effects are significant and on average amount to %18 extra growth in productivity in three years for a more financially developed country (such as Spain with private credit to GDP ratio of %75 at time of reform) compared to less financially developed ones (such as Mexico, with private credit to GDP ratio of %13). Second, to better quantify the effects of financial intermediaries on productivity improvement, output and welfare, I construct a dynamic model of heterogeneous firms in a small open economy. Calibrated numerical ex-

ercises show that if a country does not improve its financial intermediaries along with the trade reform, it loses a large portion of gains in output and productivity in the years after the trade reform. From a policy standpoint, the study's message is that improvement of financial intermediaries facilitates the achievement of goals intended by trade reforms.

I construct a model of a small, open economy with financial frictions and tariffs. The economy consists of a continuum of firms producing differentiated products and is protected from foreign competition by imposing a tariff on foreign goods. The firms are heterogeneous with respect to their productivities, however each firm has the one time option to pay a sunk cost and improve its productivity. The firms need to finance the costs up-front through the financial intermediaries, which are less than perfect. I model the financial friction as the inability of the lenders to fully insure themselves against the borrower's default risk. Therefore, the level of the debt will be limited by the strength of the financial and legal institutions to reimburse the investors upon default. Moreover, smaller borrowers will be able to borrow less and be requited to save in order to partially finance the innovation costs by themselves. In the equilibrium, the level of tariffs determines the competitive pressure and the incentives of the firms to innovate. Lowering tariffs brings up the option value of innovation as it directly affects future profits. In the presence of financial frictions, the innovation decision is delayed, as some firms have to accumulate savings to internally fund some part of the innovation costs. The delayed innovation, in turn affects their relative productivity to other firms

and adversely affects their profits and delays the innovation further. Some output, export and productivity is lost due to presence of this friction. The model is used to quantify these effects.

In the main part of the analysis, I calibrate the parameters of the model to be similar to key features of Latin American countries during the 1980s, which went through structural trade reforms. Mexico, Bolivia and Columbia went through drastic tariff reductions during these decades. However, they did not reform their financial sectors, nor did increase the financial intermediaries during these reforms until years later. I study two scenarios. In one, the country goes through tariff reduction but the level of financial intermediaries does not change. In the other, the country reduces the tariff and improves the financing as well. In both scenarios I solve for the equilibrium before and after the reform[2] The results indicate that in the presence of the frictions, around 40% of potential output and productivity gains from reduction of trade barriers is lost.

This paper contributes to the literature on the links between trade and finance. In one branch of this literature, theoretical and empirical works by Kletzer and Bardhan (1987), Freitas (2003) , Beck (2003, 2004) and Matsuyama (2005) have focused on establishing the links between financial development of a country and how it shapes the patterns of exports and comparative

[2]The transition paths to equilibrium will be incorporated soon. The transitions are important as some welfare is lost due to the slower convergence towards the new equilibrium in presence of financial frictions.

advantage through affecting different industries in different ways. A new and different branch of the literature incorporates financial frictions in the models of heterogeneous firms and studies the implications of firms sorting into exporters and non-exporters based on not only the productivities but also the level of firm's or country's financial frictions. Chaney (2004) studies a model where firms are liquidity constrained in financing the export costs. Manova (2006) introduces frictions in financing the costs of export and explores how it implies nuances in productivity cutoffs for export participation based on sectoral needs to finance as well as each country's level of financial development. My paper is different from these papers as it incorporates the option to improve firms productivities in an open economy context and models the financial frictions associated with it. Focusing on the frictions associated with innovation is of particular importance, as it is in the heart of how firms grow and invest.

The paper also relates to the literature on growth and trade. While the paper is not specifically about growth, it focuses on how trade affects the option value of innovation and thus output growth. The link between trade openness and growth has been empirically hard to establish (Rodriguez and Rodrick 1999). Moreover recent papers such as Bajona et al (2008) point out that standard models of trade do not necessarily imply links between trade openness and real GDP growth, and to the extent that trade leads to growth it might be through channels such as productivity improvement.

My paper is similar to Kambourov (2008) in terms of incorporating institutional aspects of a country in trade reform analysis as well as the numerical exercises performed. He incorporates the firing costs into the trade analysis of Latin American countries and studies how it slows down the process of labor reallocation after a trade reform.

The rest of the paper is organized as follows: section 1.2 documents the empirical facts that motivate my analysis; In section 1.3, the model is developed; Section 1.4 describes the calibration to data, numerical exercises and the results; Section 1.5 concludes.

1.2 Empirical Investigation

In this section, the empirical motivation of the paper is described. I argue that among the several countries who went through trade liberalization, there are differences in the level of productivity growth after the reform, and this pattern coincides with the ordering of the level of their financial development. In order to study the data more rigorously, I perform regressions on a large number of trade reform episodes.

1.2.1 Trade Reform

During the 1980s and early 1990s, a larger number of developing countries began to reduce their levels of protection and to reform their development strategies. Many countries, especially Latin American countries, had been im-

plementing import substitution policies for almost four decades by then and had some of the highest tariff rates in the world. During the reform period, tariffs were drastically reduced; in many countries, import licenses and prohibitions were eliminated; and several countries started engaging in free trade agreements regionally and beyond (see Edwards (94)). Kambourov (2008) reports: "The 1997 Inter-American Development Bank (IADB) report states that the average tariffs declined from 42% in 1986 to 14% in 1995, the average tariff dispersion declined from 24% down to 5%, and maximum tariffs were lowered from an average of 84% to 41%. In addition, non tariff restrictions which affected 38% of imports in the pre-reform period covered only 6% of imports in 1995".

1.2.2 Financial Development

Potentially many country specific factors can affect the outcome of trade reforms and their success in achieving the intended goals. Many of the countries which implemented trade liberalization had been implementing import substitution policies for years by protecting home industries from competition with the more efficient foreign producers. This potentially distorted the incentives to be more efficient and adopt new technologies. By lowering the trade barriers, the protection shield is weakened and innovation becomes a more attractive and necessary option. In this context, any impediment to the innovation process can hinder the intended gains from trade reform. The financial development of a country has been quoted an important institutional

feature of the country that affects the funds available to firms for investment and growth (Levine 2004). This is a broad term that addresses the quality and quantity of financial services available to firms. Many legal and technological factors have been considered as factors affecting financial development (La Porta et. al, 1998, Djankov et. al, 2007). Availability of a public credit bureau and effective record keeping system can lead to better evaluation of creditworthiness and a more efficient financial system. Level of investor protection in law, cost or ease of bankruptcy and the effectiveness of legal system in upholding contracts also affects the availability of credit. In addition, the technological specificities of a firm or sector may also make it easier or harder to determine the creditworthiness of a loan for investment. For example, it is harder to obtain finance for investments in R&D-which is very human capital intensive-compared to investment in tangible assets (Hall 2002). Overall, not only are there differences in the level of financial development across countries, but also different sectors are affected differently within the same country.

Table (1.1) lists a large number of countries who implemented far reaching trade reforms during the 70's, 80's and early 90's. The table lists the level of private credit to GDP, a measure showing the amount of funds lent to the firms by financial institutions as a fraction of GDP. The number corresponds to the average value for the 3 years before and after the trade reform date[3].

[3]Though the level of private credit to GDP varies yearly, I use an average over a number of years which is a common practice in the literature. Moreover the series does not exhibit before and after regime change expect for New Zealand during its trade reform. For Chile,

This measure, though not perfect, is one of the widely used indexes of financial development. For the topic of this paper, this measure is most relevant as it directly addresses the external funds available to firms. There is significant heterogeneity across the countries in Table (1.1) with regard to this measure. While Spain has a level of private credit to GDP, similar to those of developed countries such as France, few, such as New Zealand and Israel fall in the middle range, and most of the rest have low levels of private credit to GDP ratios (under 30%).

While Latin American countries do not exhibit very high levels, among them Bolivia and Mexico emerge as having very low levels of private credit to GDP (15% and 13% respectively). On the other hand, Chile and Uruguay have ratios almost twice as high (23% and 28%). As a simple comparison, it is interesting to note the pattern of productivity growth in these four countries after their trade reform. Edwards (1994) reports that in the late 70's when Chile's reform had been completed, Chile experienced TFP growth three times higher than its historical average. Uruguay though less spectacular, exhibited significant improvements in TFP growth in the years following the trade reform. On the other hand, Bolivia shows a flat profile of TFP growth, and Mexico even exhibits a slightly negative one, robust to different measures.

While this does not show causality, it is suggestive. To further explore

the level of private credit to GDP increases drastically but only 5 years after the reform date.

the relation of productivity growth and financial development in trade reforms, I investigate the data more rigorously in next section using data on 16 trade liberalization episodes.

1.2.3 Productivity Changes

The United Nations Industrial Development Organization (UNIDO) provides data on the number of employees and value added for 28 industries at 3-digit ISIC level, for a large number of countries[4]. Among those countries, Wacziarg and Wallack (2004) argue there are 20 trade liberalization episodes. They construct measures of trade liberalization based on not only the laws on paper (de jure liberalization) but also based on the reaction of exports to the laws on paper (de facto liberalization). They show in most cases the dates are the same except for a couple of countries where the dates are at most one year apart. Dates of liberalization in this paper is based on Wacziarg and Wallack (2004). Among these liberalization episodes I consider those with available data on value added and employment in UNIDO database for at least three years before and after the trade reform in order to be able to compare the differences. This reduces the number of trade reform episodes to 16 countries which are denoted by an asterisk in Table (1.1).

I will compare the productivity growth of different sectors before and after trade reform, and examine the relation of changes with the level of finan-

[4]The data is complied in one single database by Nicita and Olarreaga (2001) who provide a detailed description of the dataset.

cial development of the country. The dependent variable is the percent change in productivity P_{is}^t of each sector s for each country i at any given year t. The growth in productivity over τ years is denoted by

$$\Delta P_{its}(\tau) = (P_{is}^t - P_{is}^{t-\tau})/P_{is}^{t-\tau}$$

where $\tau = 2, 3$ or 4. The basic regression takes the following form

$$\Delta P_{its}(\tau) = \alpha + \beta_0 Lib_{it} + \beta_1 Lib_{it} * PC_i + \delta_i + \delta_s + \delta_t \tag{1.1}$$

where $\Delta P_{its}(\tau)$ is the productivity growth in sector s, country i at year t compared with τ years earlier; δ_i, δ_s and δ_t are country, sector and time dummies, Lib_{it} is a dummy which takes value 1 for all years after trade liberalization and PC_i is the measure of private development of country i namely the ratio of private credit to GDP. While α, δ_i, δ_s and δ_t capture average effects across industry, time, country, β_0 captures the average change in productivity growth due to liberalization, and β_1 captures whether country's specific financial features had an effect beyond the average effects of liberalizations. A positive and significant β_1 suggests trade liberalization promotes more productivity improvement if it is happening in a country with better financial intermediaries. In some versions of the regressions, δ_s and/or δ_c are replaced by $t\delta_s$ and/or $t\delta_c$ to allow for specific sector and/or country trends that might be going on as a global trend in a specific industry or country, regardless of the liberalization.

The response to trade liberalization can be slow and take years to materialize. Therefor the regressions are done for 2,3 or 4 year differences in productivity growth. The results for one year productivity growth were mixed and mostly not significant, however as I show the results for $\tau = 2, 3, 4$ are all significant in the direction that supports the hypothesis.

Table (1.1) lists the countries in the analysis and the values of private credit to GDP ratios used in the analysis. Regression results for $\tau = 2, 3$ and 4 year productivity growth are reported in Tables (1.3), (1.4) and (1.5).

The basic result is that coefficient β_1 is positive and significant at %5 and in most of specifications at %1 level. First column of Table (1.3) reports the basic treatment effect for trade liberalization on productivity growth. It shows on average the (2 year) growth rate of productivity increases by %14 in the years after the trade reform. This is significant at %1 after controlling for year, country and industry effects and specific country and industry trends (columns 2 and 3 in the same table). Then I run the regression (1.1) to examine whether the impact of trade liberalization varies across countries depending on their financial development. Column 4 of Table (1.3) reports the results. While average effect of trade reform, β_0, is still significant, its magnitude and significance is reduced, and financial development coefficient, β_1 (significant at %5), picks up the variations based on financial development. Overall, the effect on a sector-country's productivity growth compared to its normal growth rate will be $\beta_0 + \beta_1 * PC_i$. For Mexico, this amounts to %10.6, (0.08 + 0.002*13)

while for Columbia this amounts to %14 (0.08+0.002*30). Tables (1.4) and (1.5) report the effects on 3 and 4 year productivity growth. The effects die out gradually to an average %5 and %3 average jump in productivity growth for 3 and 4 year growth rates. However β_1 remains significant at %1 level for all of the specifications and the fit of regression improves (R^2 increases).

There are some issues regarding the identification of coefficient β_1. One issue is that it is possible that β_1 is not picking up the effect of financial development but rather the overall development of a country. This is an issue since financial development and GDP per capita are highly correlated. To address this issue, I control for interactions of Lib dummy with the overall development of the country proxied by GDP per capita. I also instrument for financial development by the use of legal origin and legal effectiveness, instruments that are correlated with financial development but not the productivity growth (Beck (2003), La Porta (1999)). In all cases, the effect of financial coefficient remains significant. Another issue is the measure of productivity growth. Sectoral productivity growth may not only come from upgrade and innovation, but also might be the result of movement of production (and labor) to more productive firms within the same sector. In more developed countries, there is fewer distortions in the overall economy and this is favorable for trade reforms. For example lower labor market frictions facilitate the faster movement of labor towards productive firms after a trade reform. In data, this will be observed as an increased productivity (due to movement of labor and production from less to more productive firms within a sector), however this

productivity growth may not be related to productivity upgrade and ease of financing. My measure of productivity, P_s^t, is a crude one at aggregate sector level, defined as the ratio of value added to total employment in each sector[5]. The ideal measure of sectoral productivity should also account for the distribution of production within a sector through assigning proper weights to value added of different production units within a sector. However the two measures conceptually are correlated and since we are interested about the changes in P_s^t and not the levels per se, the lack of ideal measure of sectoral productivity is less relevant. To further address this concern, I divide the sectors to two groups based on their need to external finance. Rajan and Zingales (1999) develop a proxy for external finance dependence of sectors which has been widely used in the literature since. If financial development is important for financing the needs to buy new technologies and upgrade productivity, then its effect on productivity should be more pronounced in the sectors which are more dependent on external finance. Table (1.2) lists the list of 3 digit ISIC sectors and the corresponding level of external finance dependence index. I run the basic regression (1.1) for two subsamples of sectors falling above and below the median level of external finance dependence index. The results of the regression are reported in Table (1.6). It further strengthens the case. The sectors highly dependent on external finance exhibit larger and more significant coefficients for the effect of financial development on productivity growth.

[5]An alternative measure, productivity defined as value added of the sector divided by the number of plants in the sector was not feasible due to the very incomplete data on the number of plants in UNIDO.

The empirical evidence presented so far, suggests the importance of financial development for facilitating of productivity growth when countries open up.

There still might be some issues. Trade reforms in different countries vary significantly in terms of length and depth of reform. Moreover it can be said that in some cases the small response of productivity growth to trade openness could be due to low level of distortions before the trade reform. In such a case, after the trade opening there will not be a strong response, no matter what is the level of financial development. Due to small nature of the dataset, it is not possible to control for, identify and isolate all of these effects. To further explore this and better quantify the welfare effects, in the rest of the paper I construct a structural model of small open economy with heterogeneous firms. I calibrate the model to a low financially developed Latin American country before its trade reform and quantify the gains from trade reform if the country had better financial intermediaries.

1.3 Model Set Up

I build a model of an small open economy, with differentiated goods, tariffs and financial frictions in obtaining productivity enhancing expenses. It is an small economy model as studied in Kambourov (2008), and is augmented by the possibility of drawing new productivity draws as in Costantini and Melitz(2007).

Preferences. The economy is populated by a continuum of individuals with measure one. They maximize their lifetime expected utility

$$E\sum_{t=0}^{\infty}\beta^t\widetilde{c}_t \tag{1.2}$$

where $\widetilde{c}_t$ is a composite good derived from a CES aggregation

$$\widetilde{c}_t = (\int_0^1 c_i^{\rho} di)^{\frac{1}{\rho}} \tag{1.3}$$

where c_i is the consumption of good produced in sector i, and $\sigma = 1/(1-\rho) > 1$ is the constant elasticity of substitution. Standard arguments show that domestic demand, y_i^d, for good i, is determined by the total income in the economy, Y, a price index P, and good's own price p_i. In particular, domestic demand is

$$y_i^d = (\frac{Y}{P})(\frac{1}{p_i})^{\frac{1}{1-\rho}} \tag{1.4}$$

where the price index, P, is equal to

$$P = \int_0^1 p_i^{\frac{\rho}{1-\rho}} di \tag{1.5}$$

Firms and Technology. The economy consists of a continuum of sectors each producing a good that is part of the composite good $\widetilde{c}$ defined in (1.3). All goods are tradable and each good i faces a world price p_i^w at which, foreign firms stand ready to supply any desired quantity. Sectors are heterogeneous with respect to the productivity and the world price of their product. Output in each sector is produced according to the production function

$$y_i^s = z_i l_i^{\alpha}, \qquad 0 < \alpha < 1 \tag{1.6}$$

where z_i is an idiosyncratic productivity specific to sector i, and l_i is the number of labor units employed in that sector. I assume that for each good i, there is one incumbent firm in sector i producing that good, and setting price p_i[6]. Since the only difference between the goods is the productivity of their respective firm, I use the terms good i and firm i interchangeably. Each period, each firm hires labor at the market wage rate w, and produces according to (1.6). A fraction of output is paid as wages to labor, while the rest is the firm's profit. The firm decides how to allocate this part between dividends to shareholders or keeping it as retained profits for the purposes that will be explained shortly. I assume all individuals hold the same portfolio of shares in the firms, so the dividends across all sectors are aggregated and redistributed to individuals as dividend income D. The firm has a static and a dynamic problem. First the static problem is described.

Firm's static problem. Within each period, the firm with productivity z, takes the aggregates of the economy, price index P and the wage rate w as given and decides about the price p_i , the price of good i at home country, and the amount of labor to hire. The world price p_i^w implies that p_i can not

[6]This is similar to monopolistic competition where each firm is the single producer of its differentiated good. However in my setup, each differentiated good is also produced by foreign counterparts thus each firm in home country has lower market power due to competition from abroad for the same exact good. The non-existence of competition at home for the same exact good can happen where each home firm has a patent on production of its good. Another case can be when new entrants for each sector/good pay fixed costs of entry and setting up distribution networks, and that makes expected profits from a Cournot competition with an incumbent so low that prevents entry altogether. This is similar to Ericson and Pakes (1995) where there exist equlibria that with no entry and the incumbent firm never exits.

be more than $p_i^w(1+\tau)$ or else home consumers will buy from foreign firms. Moreover p_i can not be less than p_i^w since it is not profitable for the firm i as it can sell its output abroad at p_i^w. Firm i can however, sell at price p_i at home and at price p_i^w abroad. Therefore the static problem can be characterize as

$$\begin{aligned} \max_{l_i,p_i,y^d,y^x} \Pi(z;P,w) &= p_i y^d + p_i^w y^x - w l_i \qquad (1.7) \\ y^d + y^x &= z_i l_i^\alpha \\ y^d &\leq (\frac{Y}{P})(\frac{1}{p_i})^{\frac{1}{1-\rho}} \\ p_i^w &\leq p_i \leq p_i^w(1+\tau) \end{aligned}$$

The solution to this problem is given by a cut-off rule (see Figure (1.1)). Firms with low productivity z, set higher prices and serve the home market, while firms with higher productivity set lower prices and export as well, specifically for each P and w there are cut-off points $\underline{z}$ and $\overline{z}$ such that

- If $z_i \leq \underline{z}$, then $p_i = p_i^w(1+\tau)$ and firm i only serves home market
- If $\underline{z} < z_i \leq \overline{z}$, then $p_i^w \leq p_i < p_i^w(1+\tau)$. Serves all the demand of home market and possibly exports some
- If $\overline{z} < z_i$, $p_i = p_i^w$ serves full demand of home market and exports.

This concludes the firms's static problem.

Evolution of Productivity and Firm Dynamic Problem Firm i's productivity evolves according to a known distribution $z' \sim F(z)$[7]. Moreover each firm has a one time opportunity to pay a sunk cost S_I to draw another productivity draw from a more favorable distribution $z' \sim G(z)$. This is similar to Costaninit and Melitz (2007) set-up. Thus in each period, firms are divided into the ones who have already innovated and those who have not and will consider this decision. Note that each firm can only innovate once and after the innovation jump the future productivity evolves according to the same distribution $z' \sim F(z)$.

Financial Frictions and Productivity Evolution. I assume that firms need to finance the innovation cost, S_I up-front, either by internal funds or by borrowing from financial intermediaries. This is in contrast with the benchmark models of heterogeneous firms, where firms can fully smooth the operative, fixed and sunk costs across time through financial intermediaries. The friction in this model arises from limited enforcement of debt contracts. I assume there are frictions which prohibit the perfect enforcement of debt contracts, in particular a firm can default on its debt and in case of default the lenders can only recoup their loss by confiscating a fraction γ of firm's profits each period. Differences in the value of γ represent the differences in the level of enforcement. In equilibrium, the optimal level of debt for each firm would be such that the firm has no incentive to default. The value of

[7]This can be a degenerated distribution implying constant productivity. In the calibration section, the choice of $F(z)$ will be explained.

γ affects the level of debt that the lenders are willing to lend to a firm. For example, $\gamma = 1$ means the firm loses all of its future profits in the case of default. This implies the lenders will be willing to lend up to the value of firm and still see no default. On the other extreme, $\gamma = 0$ is a case where firm sees no punishment if it defaults, and of course in equilibrium, no lender will lend to the firm and the level of debt would be zero. In the latter case, the firm has to rely on its own internal funds in order to finance the costs of innovation. This slows down the process of innovation as the firms have to save in order to accumulate enough funds to innovate. Moreover lower dividends, lowers the available income by consumers and adversely affects the profits of the firms and consequently slows down the accumulation of internal funds even further.

I assume there are financial intermediaries who lend and accept deposits at rate r. Firms dynamic problem involves whether to innovate in any specific period if they have not done so already, and if yes, how to finance the costs. Firm has the option to borrow subject to the enforcement contracts and can also finance part of the costs through its own savings. The savings are the retained profits of the firm which have been deposited at rate r.

Each firm discounts future at rate β and dies with per period probability ϕ. Let $i \in \{0, 1\}$ denote whether firm has innovated or not. and let d denote the level of debt or saving of the firm ($d > 0$ denotes saving and $d < 0$ denotes debt). Firm's recursive problem for those who have already innovated is

$$V(z,1,d) = \max_{d'} \quad \Pi(z;P) + (1+r)d - d' + (1-\phi)\beta EV(z',1,d') \tag{1.8}$$
$$st. \;\; \Pi(z;P) + (1+r)d - d' \geq 0 \quad \text{(dividend condition)}$$
$$EV(z',1,d') \geq (1-\gamma)EV(z',1,0) \quad \text{(no default condition)}$$

The dividend conditions means that firms can not issue new shares. I assume they should pass a non-negative dividend $D(z,i,d) = \Pi(z;P) + (1+r)d - d'$ to the shareholders. In the no default condition, the left hand side represents the value of not defaulting and the right hand side the value of defaulting in which case only fraction $1-\gamma$ of each period's profit is left for the firm and the rest is confiscated by the lenders. The firm's problem in this case is simpler and reduces to smoothing the debt over time subject to no default.

If a firm has not innovated yet, its recursive problem is characterized by

$$V(z,0,d) = \max_{d',I\in\{0,1\}} \quad \Pi(z;P) + (1+r)d - d' - I \times S_I + (1-\phi)\beta EV(z',I,d') \tag{1.9}$$
$$st. \;\; \Pi(z;P) + (1+r)d - d' - I \times S_I \geq 0 \quad \text{(dividend condition)}$$
$$EV(z',I,d') \geq (1-\gamma)EV(z',I,0) \quad \text{(no default condition)}$$

This completes the description of firm dynamic problem.

Entrants At the beginning of each period, death shocks are realized. Continuing firms optimize based on (1.8) and (1.9). New entrants can pay sunk cost

S_E and draw a productivity from a known distribution $H(z)$ and start off as firms that have not innovated yet. Expected value of entry is

$$V^E = \int V(z,0,0)h(z)dz - S_E$$

which should be non negative in equilibrium to allow for entry of a positive measure of firms. In equilibrium the number of entrants should be such to replace the measure of dead firms, leading to a constant measure of firms.

The nature of firms entry cost and dividend payment rules imply that the representative consumer's income in each period equals

$$Y = \int_{z,d,i\in\{1,2\}} \underbrace{D(z,i,d)}_{\text{dividend}} - E \times S_E$$

Distribution of firms. Given the death of some of firms and the initial distribution of entrants, the distribution of firms is determined by the firms' decisions (innovate or not) , level of debt or saving, and the stochastic evolution of firms' productivities. Starting with distribution of firms $M_{t-1}(z,i,d)$, at the beginning of period t, death shocks are realized. The firms' policy decisions and the evolution of productivities lead to the distribution of continuing firms, $M_t^C(z,i,d)$. The incumbent firms together with the new entrants, distributed as $E_t(z,0,0)$ constitute the firm distribution

$$M_t(z,i,d) = M^C(z,i,d) + E(z,0,0)$$

Equilibrium. An stationary equilibrium is characterized by stable aggregate values for P, Y, w, r. The equilibrium conditions are related to the firms' and

consumer's optimal decision, value of entry and full use of resources. The stationary equilibrium is characterized by

- Aggregate s P, Y and prices w, r, p_i^w
- Firm's Value Function $V(z, i, d)$, Innovation Policy Function $I(z, 0, d)$ and debt Function $d(z, i, d)$ satisfying (1.7),(1.8) and (1.9).
- Distribution of firms $M(z, i, d)$
- Distribution of new entrants $E(z, 0, 0)$
- Distribution of firms is consistent with firm decisions and entrants distribution
- Aggregates P and Y are consistent with firm decisions and all resources are used.

Some aspects of the equilibrium are worth noting. In equilibrium positive entry is needed to counterbalance the death of firms. The value of entry should be non negative to allow for entry. A positive value of entry leads to entry of too many firms, therefore in equilibrium the value of entry should be exactly zero, and the measure of entering firms should be exactly equal to those who exit due to death shock.

There is not an ordering of firms based on productivity. Even though more productive firms are more likely to innovate, innovation also depends

on the level of savings. Two firms with the same level of productivity might make different innovation decision due to their different level of savings which translates to different abilities of financing the costs of innovation. This is in contrast with the frictionless scenario where the only variable affecting the innovation decision is the current productivity of the firm.

Financial frictions affect the aggregate productivity and output in a couple of different ways. First, as explained some firms are prohibited from productivity improvement due to lack of funds even though they could have done it profitably in a frictionless economy Second, firms who need to innovate might have to also finance part of the innovation costs internally. This diverts some funds from dividends to savings and lowers the total income of the consumers. This in turn lowers the demand, profitability and value of the firms and makes their constraints tighter, requiring more savings. This is the indirect income effect adversely affecting the innovation in presence of frictions.

To explore the numerical implications of the model, a computational method for finding the stationary equilibrium is developed as described in the appendix. Next section explains the choice of parameters and describes the numerical analysis.

1.4 Numerical Exercises

To study the effects of financial frictions on output and productivity when a country implements trade reforms, I consider the case of Mexico after its trade reform of 1986. Mexico, had a very low level of private credit to GDP of %13 during these period until 1990. The pattern of FDI inflows and stock market capitalization during the reform years until 1995 shows that during this time the way firms usually obtain access to funds and technology have not changed much. FDI inflows almost grow at the same rate as before and ratio of FDI/GDP remains around %1 well until 1995 at which time it drastically increases to %3. The absolute value of FDI flows in 1995 and following years is around 3-4 times the value of FDI inflows in years before and after 1986. During first years of reform Stock market capitalization remains at around %12 until 1993 and then starts growing faster (compare this to the %30 ratio for Chile at 1986). I conclude that Mexico at the time of its trade reform in 1986 emerges as a country with limited financial resources available to its firms.

I calibrate the parameters of the model to the specifics of Mexican economy in the 1986 as a distorted economy with high tariffs and low level of financial development. Then I study the economy under two scenarios. First, the tariffs are reduced but the level of financial development is the same. In second scenario, the tariffs are reduced and the financial frictions are removed as well. In both scenarios I solve for the stationary equilibrium and compare

the levels of output and welfare. The difference between the two scenarios quantifies the effects of financial frictions.

Choice of parameters and Results. Tables (1.8) and (1.9) summarize the choice of parameters. Some parameters are chosen according to the common choices in the literature or to reflect empirical findings on firm dynamics across countries. I chose $\beta = 0.95$ to reflect an annual interest rate of %5. The elasticity of substitution is set at $\sigma = 2.5$ which implies ρ =0.6.The share of labor in output is set to $\alpha = 0.6$. The death shock is set at $\phi = \%10$ according to Bartelsman (2003).

The choice of evolution of productivities for continuing, innovating and entrants is chosen based on the analysis of firm dynamics by Costantini and Melitz (2007). I assume that for continuing firms that have not innovated the evolution of productivity is log-normally distributed around the current period's productivity , i.e. $\log(z')$ is normal with mean of $\log(z)$ and standard deviation of %2 (with truncation of extreme ends to avoid accumulation of firms at the end of grid points). While it is not necessary for the qualitative analysis that $z'|F(z)$ be a non-degenerated distribution, it makes the computing of firms distribution and decisions easier by allowing for smoother transitions across innovation states and smoother distributions and value functions[8].

[8]It can also be argued that in reality existence of uncertainty induces some inaction in firm's innovation decisions. This is on top of the inaction due to financial friction. Using relevant data moments one could isolate and identify each of these effects. This is not the route taken in this paper though.

The effect of innovation is assumed to be a %10 increase in productivity on average, in the sense that for innovating firms $\log(z')$ is distributed normally with mean $\log(1.1z)$ and standard deviation of %2 (with truncated extremes). Finally The entrants are log-normally distributed on the lower end of the grid.

The rest of parameters w, p^w, γ, S_I and S_E are chosen by solving the model and matching certain moments. First w is normalized to one. While p^w, γ, S_I and S_E jointly affect the economy outcomes, some are more directly related to a certain moment than others. The world price p^w, affects the comparative advantage of the economy and thus the ratio of exports to GDP. The parameter γ, summarizing level of financial development affects the tightness of borrowing (and default) constraints and the level of debt, private credit to GDP. The magnitude of sunk cost of innovation affects the chances of productivity improvement, and thus indirectly affects the chances of becoming an exporter and the number of exporting firms. The level of sunk costs of entry S_I is chosen relative to the sunk cost of innovation similar to Costantini & Melitz (2007).

The parameters of the model are then used to run two scenarios. Table (1.10) summarizes the results of numerical exercises. Second and third columns show the real output, productivity and welfare compared to the normalized case of Mexico before trade reform (first column). The first column is an economy with high tariff rates and low level of financial development such as Mexico in 1986. The second column corresponds to the new stationary

equilibrium for the same economy when the tariff rates are reduced but the level of financial development has remained the same. The third column is the stationary equilibrium of a counter-factual scenario, where the tariffs have been reduced to %15 and the financial frictions has been eliminated.

Table (1.10) reports the results. First of all, removing both tariffs and financial frictions, improves output, welfare and productivity significantly. Comparing columns (2) and (3) show that if financial frictions persist after the trade reform as much as %40 of gains in terms of output, welfare and productivity is lost. This is quantitatively very large and underlines the importance of better financial intermediaries at the outset of trade reforms.

1.5 Conclusion

The paper argues that productivity improvement is an important goal intended by trade reforms, and therefore it is important to document and quantify the effects of impediment to productivity growth in the trade reforms. The paper does so by providing empirical evidence of the importance of financial development in the productivity growth after trade reforms. The quantitative exercises show that the lost gains from underdevelopment of financial intermediaries, can be significant in terms of welfare, output and productivity.

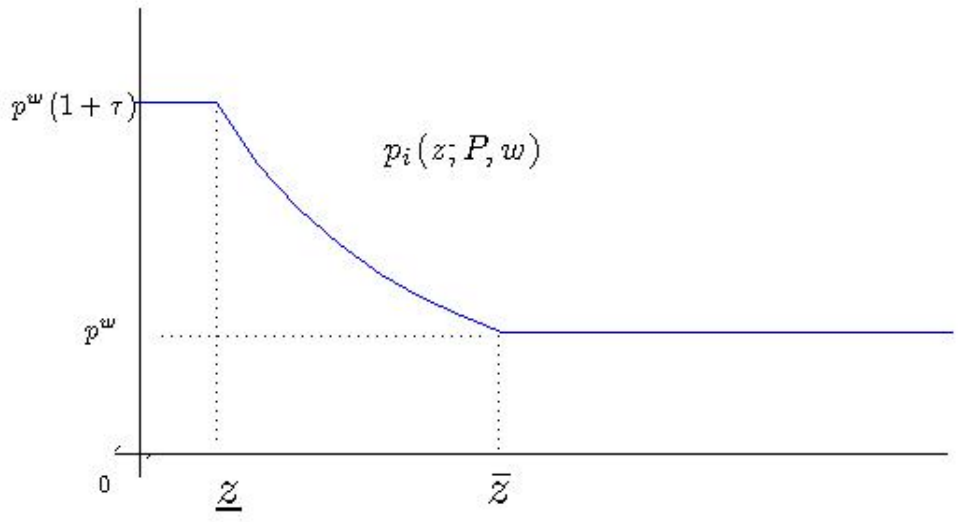

Figure 1.1: Price function

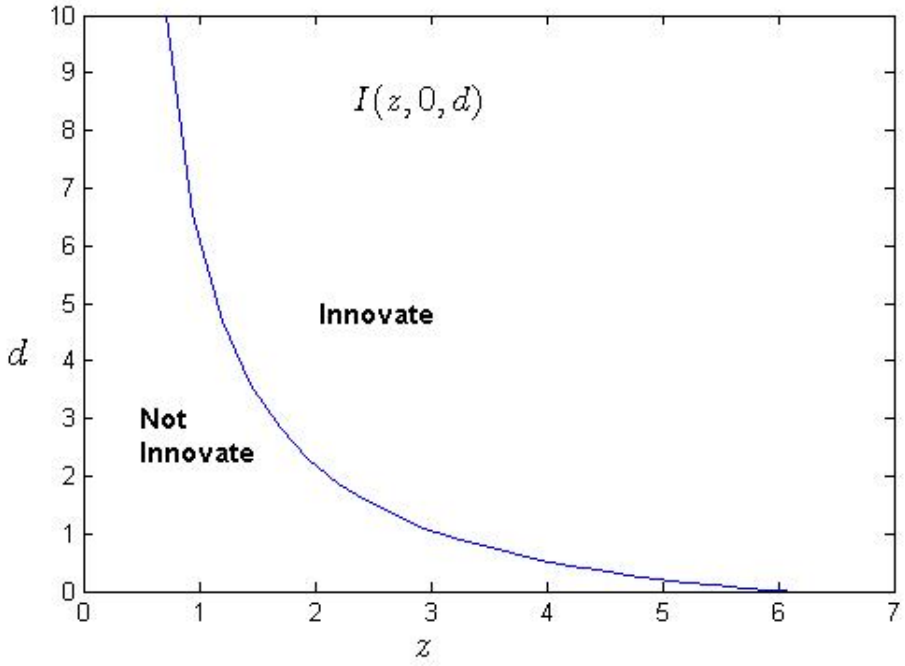

Figure 1.2: Policy function $I(z, 0, d)$

1.6 Appendix: Computational Algorithm

- Set parameters
- Guess P, Y
- Solve for firm's static production and profit functions
- Guess and Repeat dynamic policy and value functions until convergent
- Solve for distribution of firms
- Update P, Y
- Repeat until convergence

Table 1.1: List of Countries in the Analysis of Chapter 1

	De facto year of Liberalization	Years available in UNIDO	Private Credit/GDP
Argentina	1976	1984-90, 93-98	
Bolivia*	1986	1976-2000	15
Chile	1976	1976-2000	23
Colombia*	1991	1976-2000	30
Ecuador*	1991	1984-2002	16
Ghana*	1985	1976-1987, 1993-1995	3
Guatemala	1989	1976-1988, 1991-1995	
Hungary*	1993	1976-2000	25
India*	1994	1976-2001	23
Israel*	1987	1976-1996	57
Kenya*	1993	1976-2002	31
Mexico*	1987	1976-2000	13
Morocco	1987	1976-1980, 1987-2002	
New Zealand	1987	1976-1991	55
Phillippines*	1988	1976-1997	21
Poland*	1990	1976-1993	22
Spain*	1979	1976-2000	75
Sri Lanka*	1991	1979-1983, 1987-2000	9
Turkey*	1990	1976-2000	13
Uruguay*	1990	1976-2000	28

Notes. Dates of liberalization are from Wacziarg and Wallack (2004).
Private Credit to GDP data is from WDI database and is averaged for 3 years before . and after trade reform dates. The pattern of that series does not change during this time interval except for New Zealand.

Table 1.2: External Finance Dependence Index

ISIC codes	ISIC 2 description	External Finance Dependence
311	Food Products	0.1368
313	Beverages	0.7772
314	Tobacco	-0.4512
321	Textiles	0.4005
322	Apparel, except footware	0.0286
323	Leather and its products and substitutes except footware and apparel	-0.1400
324	Manufacture of footware, except rubber or plastic	-0.1400
331	Wood products except furniture	-0.0779
332	Furniture except metal	0.2840
341	Paper and paper products	0.2357
342	Printing and publishing	0.1756
351	Industrial chemicals	0.2038
352	Other chemicals	0.2187
353	Petrolum refineries	0.0420
354	Misc. products of petrolum and coal	0.3341
355	Rubber products	0.2265
356	Plastic products n.e.c.	1.1401
361	Pottery, china and earthenware	-0.1459
362	Glass and glass products	0.5285
369	Other non-metallic mineral products	0.0620
371	Iron and steel industries	0.0871
372	Non-ferrous metal industries	0.0055
381	Fabricated metal product, except machinery and equipment	0.2371
382	Machinery except electrical	0.4453
383	Electrical machinery	0.7675
384	Transport equipment	0.3069
385	Professional and scientific	0.9610
390	Other manufacturing	0.4702

Table 1.3: Trade Liberalization and Productivity Growth in 2 Years

COEFFICIENT	(1)	(2)	(3)	(4)	(5)	(6)
Lib	0.1398***	0.1399***	0.1399***	0.0749**	0.0750**	0.0750**
	(0.0283)	(0.0283)	(0.0283)	(0.0371)	(0.0371)	(0.0371)
Lib* Private Credit				0.0028***	0.0028***	0.0028***
				(0.0010)	(0.0010)	(0.0010)
Year dummies	Y	Y	Y	Y	Y	Y
Industry dummies	Y	Y	N	Y	Y	N
Country dummies	Y	N	N	Y	N	N
Industry-specific trends	N	N	Y	N	N	Y
Country-specific trends	N	Y	Y	N	Y	Y
Observations	4277	4277	4277	4277	4277	4277
Adjusted R^2	0.118	0.118	0.118	0.119	0.119	0.119

Standard errors in parentheses. *** p< 0.01, ** p< 0.05, * p< 0.1

Note. Lib is a dummy variable equal to 1 for all years after trade reform.

Regression specification :

$$\Delta P_{its}(\tau) = \alpha + \beta_0 Lib_{it} + \beta_1 Lib_{it} * PC_i + \delta_i + \delta_s + \delta_t$$

Table 1.4: Trade Liberalization and Productivity Growth in 3 Years

COEFFICIENT	(1) All dummies	(2) Country Trend	(3) Country & Industry Trends	(4) All dummies	(5) Country Trend	(6) Country & Industry Trends
Lib	0.0636**	0.0636**	0.0636**	-0.0956**	-0.0956**	-0.0956**
	(0.0320)	(0.0320)	(0.0320)	(0.0422)	(0.0422)	(0.0422)
Lib*Private Credit				0.0068***	0.0068***	0.0068***
				(0.0012)	(0.0012)	(0.0012)
Year dummies	Y	Y	Y	Y	Y	Y
Industry dummies	Y	Y	N	Y	Y	N
Country dummies	Y	N	N	Y	N	N
Industry-specific trends	N	N	Y	N	N	Y
Country-specific trends	N	Y	Y	N	Y	Y
Observations	4111	4111	4111	4111	4111	4111
Adjusted R^2	0.160	0.160	0.160	0.166	0.166	0.166

Standard errors in parentheses. *** p< 0.01, ** p< 0.05, * p< 0.1

Note. Lib is a dummy variable equal to 1 for all years after trade reform.

Regression specification :

$$\Delta P_{its}(\tau) = \alpha + \beta_0 Lib_{it} + \beta_1 Lib_{it} * PC_i + \delta_i + \delta_s + \delta_t$$

Table 1.5: Trade Liberalization and Productivity Growth in 4 Years

COEFFICIENT	(1) All dummies	(2) Country Trend	(3) Country & Industry Trends	(4) All dummies	(5) Country Trend	(6) Country & Industry Trends
Lib	0.0262	0.0392	0.0392	-0.1852***	-0.1853***	-0.1853***
	(0.0351)	(0.0409)	(0.0409)	(0.0541)	(0.0541)	(0.0541)
LibPC3				0.0094***	0.0094***	0.0094***
				(0.0015)	(0.0015)	(0.0015)
Year dummies	Y	Y	Y	Y	Y	Y
Industry dummies	Y	Y	N	Y	Y	N
Country dummies	Y	N	N	Y	N	N
Industry-specific trends	N	N	Y	N	N	Y
Country-specific trends	N	Y	Y	N	Y	Y
Observations	4137	4174	4174	4174	4174	4174
Adjusted R^2	0.209	0.176	0.176	0.184	0.184	0.184

Standard errors in parentheses. *** p< 0.01, ** p< 0.05, * p< 0.1
Note. Lib is a dummy variable equal to 1 for all years after trade reform.
Regression specification :

$$\Delta P_{its}(\tau) = \alpha + \beta_0 Lib_{it} + \beta_1 Lib_{it} * PC_i + \delta_i + \delta_s + \delta_t$$

Table 1.6: Trade Reform and Sectoral Productivity Improvemen, Different sectoral reactions based on External Finance Dependence

COEFFICIENT	(1) High Exf	(2) Low Exf
Lib	0.0521*	0.0946*
	(0.0235)	(0.0551)
Lib* Private Credit	0.0040***	0.0018
	(0.0014)	(0.0015)
Year dummies	Y	Y
Industry dummies	Y	Y
Country dummies	Y	Y
Observations	2152	2125
Adjusted R^2	0.144	0.092

Standard errors in parentheses *** p< 0.01, ** p< 0.05, * p< 0.1
Regression Specification:.

$$\Delta P_{its}(\tau) = \alpha + \beta_0 Lib_{it} + \beta_1 Lib_{it} * PC_i + \delta_i + \delta_s + \delta_t$$

Table 1.7: Trade and Productivity Upgrade: Sectoral response based on Comparative Advantage

COEFFICIENT	CV=1	CV=0
Lib	0.0146	0.1620***
	(0.0514)	(0.0542)
Lib*Private Credit	0.0025*	0.0025*
	(0.0014)	(0.0015)
Observations	2129	2160
Year dummies	Y	Y
Country dummies	Y	Y
Industry dummies	Y	Y
Adjusted R^2	0.095	0.102

Standard errors in parentheses *** , ** and * denote significance at 1,5 and 10 percent.

CV= 1 indicates sectors that have a comparative advantage (according to Balassa Index) in the corresponding country in the year of liberalization.

Regression specification:

$$\Delta P_{its}(\tau) = \alpha + \beta_0 Lib_{it} + \beta_1 Lib_{it} * PC_i + \delta_i + \delta_s + \delta_t$$

Table 1.8: Choice of Parameters, Case of Mexico

Parameter	Description	Comment
$\beta = 0.95$	%5 annual interest rate	
$\rho = 0.6$	such that elasticity of substitution σ =2.5	
$\phi = 0.10$	Probability of exogenous death shock at plant level	Bartelsman(2003)
$z'\|F(z)$ productivity transition	log normal with mean z, std 0.02	Costantini Melitz (2007)
$z'\|F(z)$ transition at innovation	log normal with mean $1.1z$ and std 0.02	Costantini Melitz (2007)
$G(z)$ new entrants	lognormal distributed on lower end of the grid	Costantini Melitz (2007)
τ = %60	Average tariffs before trade reform	IADB(1997)

Table 1.9: Choice of Parameters by Solving the Model, Case of Mexico

Parameter	Description	Target Data
$w = 1$	Normalization	
p^w	Affects comparative advantage	Export/GDP = %16
γ	Level of financial development	Credit/GDP= %13
S_I	Sunk cost of investment	%10 of firms export IADB(1997)
S_E	Sunk cost of entry	s.t. $S_I/S_E = 5$ Costantini Melitz(08)

Table 1.10: Numerical Exercise, Case of Mexico

	Economy 1	Economy 2	Economy 3	Economy 4
	$\tau = \%60$ Low Fin. Dev	$\tau = \%15$ Low Fin. Dev.	$\tau = \%15$ High Fin. Dev.	$\tau = \%60$ High Fin. Dev.
Real output	100	105	109	104
Productivity	100	106	110	106
Welfare	100	106	110	105
Export/Output	%16	%25	%30	%23

Table 1.11: Choice of Parameters by Solving the Model, Case of Average Country (Mexico, Bolivia, Chile)

Parameter	Description	Target Data
$w = 1$	Normalization	
p^w	Affects comparative advantage	Export/GDP = %20
γ	Level of financial development	Credit/GDP= %18
S_I	Sunk cost of investment	%20 of firms export IADB(1997)
S_E	Sunk cost of entry	s.t. $S_I/S_E = 5$ Costantini Melitz(08)

Table 1.12: Numerical Exercise, Case of Average Country (Mexico, Columbia, Bolivia)

	Economy 1	Economy 2	Economy 3
	$\tau = \%42$ Low Fin. Dev	$\tau = \%15$ Low Fin. Dev.	$\tau = \%15$ High Fin. Dev.
Real output	100	104	107
Productivity	100	105	106
Welfare	100	105	106
Export/Output	%20	%25	%30

Chapter 2

Firm Size Distribution, Trade Openness and Financial Development: an Empirical Analysis

2.1 Introduction

There is a large and growing literature on the ways that international trade affects firms decisions and distribution. This literature emphasizes that competitive pressure resulting from low tariffs induces larger and/or more productive firms to grow to export markets and at the same time, smaller and/or less productive firms are induced to exit or shrinkage.

This paper contributes to this literature by providing new empirical evidence that openness pressure affects larger and smaller firms differently and this effects are magnified in the presence of financial frictions. While most of the empirical literature on effects of trade on firms' decision, tend to focus on firm level databases within a country, this paper makes use of comparable cross-country data on firm size distribution and firm decision. Thereby providing evidence that the aforementioned asymmetric effects hold true in cross-country comparison as well.

The basic idea is that the level of trade protection in a country affects the level of competitive pressure the firms are facing. Low levels of tariffs,

increase the pressure from foreign competitors thus increase the incentives to become more efficient. Larger firms are likely to grow to export markets, while smaller firms are likely to lose business unless they improve their efficiency. Financial frictions, however, limit the ability of firms to upgrade their technology, and this is more hindering for smaller firms. This asymmetric effect motivates the hypothesis of this paper. The paper hypothesizes that lower levels of trade protection along with lower levels of financial development leads to bigger disparity in firm size distribution. This is the first hypothesis that the paper tests.

At the firm level, the same theoretical argument would lead one to expect that larger firms in countries with lower trade protection and lower financial development tend to have an advantage in upgrading their technologies compared to their smaller compatriots. I use a comparable cross-country dataset by World Bank, which provides firm level information on technology upgrading of firms. I provide further evidence that financial development affects firms decisions in an asymmetric manner. This is the second hypothesis that the paper tests.

The paper uses two cross-country databases and two tests to provide evidence for the within industry effects of trade and financial development. This topic is important for several reasons. First, many counties have programs to support small and medium size enterprises (SME) and spend large sums of money to subsidize SMEs with the hope of promoting growth and

employment. This paper does not have a view on success of such policies, however it sheds light on the ways such policies, if deemed beneficial, could be enhanced. Given that SMEs are most vulnerable in trade liberalizations, the policies could give considerations to improving financial services in order to facilitate technology upgrade by SMEs. Second, it shows financial development has secondary impacts on composition of production and distribution of resources, beyond its overall impact on growth.

This paper uses a double difference approach to test the two hypotheses put forth above. First, Business Size Class data across OECD countries is used which provides us with information on distribution of production units across various sizes within each industry. Using this information, a summary-statistic of firm size disparity within industries across countries is constructed. Double difference regressions are used to test that for any level of trade openness, how much financial restrictions add to the disparity in firm size distribution. Various controls are included to isolate the effect. Results are significant and are not due to simultaneity or reserve causality. Second, we turn to a firm level survey conducted by World Bank across a large number of developing countries. The advantage of this dataset is that it involves developing countries and moreover it provide us with firms' responses on their choice of technology upgrade and a host of other firm characteristics. To determine the asymmetric impact of trade openness and financial development on firms decision, a double difference approach is employed to isolate the impact of trade openness, financial development and size. The results indicate as access to financial services

improve, the probability of technology upgrade increases for all but more so for smaller firms, and this effect is more pronounced the more trade is open.

The results contribute to different literatures. One is the literature on determinants of firm growth and the role of financial development. This literature examines the way financial development shapes the growth and composition of industries. There is a large literature, starting with LaPorta, Lopez-de-Silanes, Shleifer, and Vishny (1998) that argues that a country's legal and financial systems is a significant determinant of the financing of firms. Demirguc-Kunt and Maksimovic (1998) and Rajan and Zingales (1998) have stressed the importance of the financial system and the rule of law for relaxing firms' external financing constraints and facilitating their growth. While the firms in the same country, face similar institutions, constraints are felt harsher by smaller firms due to a host of reasons, for example the smaller ability to generate funds internally. This has been the focus of a theoretical and empirical literature, for instance, Cooley and Quadrini (2001) and Beck et al (2005). While this literature, considers several macroeconomic factors in play, such as the overall market size (GDP), it overlooks an important component of the macroeconomic landscape, namely the level of openness to international trade as a driving force in industry dynamics. This paper contributes to this literature, by highlighting the international trade channel though which competitive pressures affects firms incentives for growth/upgrade and financial friction's effects are felt by firms through this channel.

The paper also relates to the literature on trade and finance. Among others, several theoretical and empirical works by Kletzer and Bardhan (1987), Freitas (2003) , Beck (2003, 2004) and Matsuyama (2005) have focused on establishing the links between financial development of a country and how it shapes the patterns of exports and comparative advantage through affecting different industries in different ways. Similarly this paper uses cross-country data and benefits from cross-industry/cross-country differences for identification, however it is different as it focuses on within industry effects such as the size distribution within industry.

The paper is organized as follows. Next section, introduces the empirical strategy to test two hypothesis on the relative size of firms within industry, as well as a test on upgrading decision of firms. Section III, discusses the first test, data and results Section IV, discusses the second test, relevant data and results. Section V offers some conclusions.

2.2 Firm Size Distribution

2.2.1 Empirical Strategy

Regarding the firm size distribution, the hypothesis is that high levels of financial obstacles is conducive to larger disparity in firm size distribution especially in industries with high trade openness-where firms are hard pressed for technology upgrade. To capture the effect, a measure of disparity in firm size distribution is every country-industry pair is regressed on the variables of trade openness and financial obstacles. Since we are interested in how the effect

of financial obstacles varies with trade openness, we allow the the coefficient on financial obstacles vary with trade openness, i.e. the regression is on the interaction of those two variables. The dataset includes ?Number of OECD countries and ? Number of industries characterized by ISIS 3 digit.

The outcome variables are measures of relative size of firms in different points of distribution. For example, $P_{ij}^{95/25}$ is the ratio of the size of the firm in the 95th percentile of the distribution to size of the firm in the 25th percentile for industry i and country j. The set of regressions cover most of the firm size distribution, with the extreme points avoided. Using the same notation, the disparity measures are $P^{95/25}, P^{95/50}, P^{95/75}, P^{75/50}, P^{75/25}$ and $P^{50/25}$. The basic regression is

$$\begin{aligned} P_{ij}^{75/50} &= \beta_T TO_{ij} * FINOBST_i \\ &+ \beta_e EXT * FINOBST + \beta_r RD * FINOBST \\ &+ \alpha + \sum_i \alpha C_i + \sum_j \alpha_j I_j + \sum_k \delta_k X_{i,k} * Y_{j,k} + \epsilon_{\iota j} \end{aligned} \tag{2.1}$$

The subscribes i and j denote country and industry respectively. In the first interaction term, TO_{ij} is a measure of trade openness in country i and industry j. The measure will be the difference of number 100 and the level of tariff in the relevant country-industry pair, where tariff is expressed in percent points. The variable $FINOBST_i$ is the measure of financial obstacles in country i and is a country-level variable. To create a proxy for financial

obstacles, we use the inverse of the level of private credit to GDP for country i. Private credit to GDP is the most preferred measure of financial development used in the literature, and will be so in this paper as well, however robustness analysis with respect to our proxies of financial development will be conducted as well. The regression also includes the interaction of $FINOBST_i$ with two other variables, namely EXT_j and RD_j. The industry level variable EXT_j, is a measure of dependence of firms within industry j on external finance, and RD_j is a proxy for intensity of R&D activity within industry j. The reason to include these two interaction terms, is that they provide channels through which firms could be affected asymmetrically. For example, in countries with high financial obstacles and in industries with high dependence on external finance for investment, larger firms might find it easier to obtain finance and hence we might observe a more unequal distribution. For similar reasons, the regression controls for interaction of several other industry and country characteristics, $X_{i,k}$ and $Y_{j,k}$. They will be factor endowment of the country and factor intensity of the industry. The idea is that in industries that make use of a specific factor intensely, big firms will have a comparative advantage compared to smaller firms when they are both competing for the same factor in countries that are not abundant in a specific factor. Finally, $\epsilon_{\iota ij}$ is the error term.

The approach is a double difference approach that is commonly used in literature. It was introduced in Rajan and Zingales (1998) to deal with the endogeneity problem in cross country studies. Using the interactions, we

analyze the differential impact of financial obstacles on various levels of trade openness in industries. The framework, reduces the bias of omitted variables, as it focuses on differential impacts rather than the direct levels. Once the fixed industry and industry dummies are included, only control variables that vary both with country and industry need be included. Since the specification controls for country-specific effects and industry-specific effects, the only effects that are identified are those relative to variables that vary both cross countries and cross industries. The assumption that enables us to identify the interaction effect is that the omitted variables are unlikely to be correlated with the interaction of trade openness and financial development.

The coefficient of interest is β_T. A significant and positive β_T is what our hypothesis leads us to expect. It will basically mean that controlling for other country and industry level effects, for a level of trade openness, as financial obstacles become tougher, disparity in firm size increases.

2.2.2 Data

This section describes the variables used in the analysis of firm size distribution. These include measures of disparity of firm distribution within each country-industry pair, industry level variables and country level variables.

2.2.2.1 Dependent Variable: Measures of Disparity in Firm Size Distribution

I construct measures of disparity in firm size distribution building up from the industry level data provided in the Business Statistics by Size Class (BSC) database compiled by OECD secretariat [1]. This database provides information relating to business activities broken down by industrial sector and size class. The industrial sector classification, is according to the International Standard Industrial Classification (ISIC), revision 3. Moreover, the information is broken down into employment size classes. Employment size classes comprise of five different size classes where the data across countries and variables can be most closely aligned. Each size class comprises of firms with sizes within one of the following ranges [2]:

$$1-9, 10-19, 20-49, 50-249, 250+$$

The database provides the number of enterprises and the number of total employers for each ISIC3 code and each of the five aforementioned size classes. Provided with the number of enterprises in each size class, a cumulative distribution of number of firms according to size is constructed. This

[1] The BSC database is part of the larger Structural and Demographic Business Statistics database by OECD.

[2] Not all countries report according to this size class category. Variations in cutoffs exist. For example, US reports its data according to cutoffs $1-9, 10-19, 20-99, 100-499, 500+$, that is why BSC calls the categories National Size Classes: NSC1, ...NSC5. This is not material to our purpose, as will be realized from the construction of our disparity measure.

cumulative distribution is very crude in the sense that it is built over 5 size classes, as such it does not allow for very precise measures of disparity in distribution. Therefore, I construct simple intuitive measures of disparity based on relative size of firms in varying points of the distribution.

To better illustrate, suppose we would like to construct $P^{75/25}$ as the ratio of the size of the firm in the 75th percentile of the distribution to the size of the firm in the 25th percentile of the distribution for a given industry and given country. Using the cumulative distribution, one can see that, say, 75th percentile firm in industry code code, say 131, lies within which one of the size bins. While we do not have the exact size of the 75th percentile firm, we will use the average firm size in the corresponding bin as a proxy for the size of the 75th percentile firm. The same method is used to identify the bin in which the 25th percentile firm lies, then the average size of firms in that bin is used as a proxy for the size of the 25th percentile firm. Having the two numbers, $P^{75/25}$ is obtained as the ratio of the size of the 75th percentile to 25th percentile firm. This method is used to construct the relative size of firms across various point in firms size distribution, namely $P^{95/25}, P^{95/50}, P^{95/75}, P^{75/50}, P^{75/25}$ and $P^{50/25}$. Given the unrefined nature of the underlying firm distribution, the end points are avoided.

BSC provides data for OECD countries from 1995-2003. However the availability of data across years varies greatly across countries, with better availability of data from 2000 onwards. We have chosen the data for year

2001 as the basis of comparison, as it was the year that the largest number of countries had provided the data. This leaves 24 countries in our database (see table ? for a list of countries).

In terms of industries included in the analysis, 55 industries at 3 digit level of ISIC rev.3 characterization are included. BSC provides data at the 2 digit and 4 digit levels as well. The reason to choose the 3 digit level is a trade-off. On the one hand, it is desired to choose a level as refined as possible to make use of the most available information. On the other hand, there was a restriction by the coverage of tariff rates that were available only up to the 3 digit level. Those considerations resulted in focusing on the 3 digit level refinement and forgo the finer 4 digit and rougher 2 digit.

For each of the 24 countries and 55 industries, the measures of disparity in firm size were constructed. However not all of the country-industry pairs had complete data on size classes to result in a observation on disparity.

2.2.2.2 Measures of Trade Openness

Tariffs are a simple and widely available measure of trade restrictiveness. Therefore to construct a measure of trade openness for each country-industry pair, 100 minus level of tariffs in the respective country-industry pair is used. The tariff data is taken from the Trade, Production and Protection database (TPP), compiled by World Bank Trade group and described in Nicita and Olarreaga (2006). Among other variables, the database provides measures

of simple tariff, weighted tariff, and non-tariff barriers to trade for a large number of developed and developing countries and for 28 manufacturing sectoring corresponding to the 3-digit ISIC, revision 2. The database covers potentially 100 countries for 1974-2004 however coverage varies greatly across countries and years.

Tariff data are provided according to ISIC revision 2 in the TPP database. Since the BSC data, the basis of our disparity measures are based on 3rd revision of ISIC, conversion tables provided by UN are used for matching of ISIC 3 to ISIC 2 codes.

TPP database provides three measures of trade barriers. Simple average tariff, weighted average tariff and a proxy for non-tariff-barriers. The analysis in this paper, makes use of the simple average tariff. For robustness analysis, weighted average tariffs are also used, however non-tariff-barriers have not been used due to its poor availability in TPP database. In particular the coverage is very poor for the year 2001. In TPP database, Simple Applied Tariff represents the simple average applied tariff rate applied on goods entering the country. Applied rates take into consideration the available (however, not complete) data for preferential schemes (i.e. the applied average tariff takes the tariff rates for each partner that export to the market country in constructing the average). Applied Tariff is reported in percentage points. Weighted applied tariff is similarly defined however it is defined as import weighted average applied tariff rate applied on goods entering the country.

Simple and weighted tariff are highly correlated and also correlated with tariff in the previous years, see Table ? . In addition to simple and weighted tariff, an average of tariff for the lagged years is used in the analysis. The reason to use lagged tariff is that outcome variables observed in each year are the result of trade policies in the previous year, therefore one should not only focus on contemporaneous policy variables. The results reported in this paper, make use of the average simple tariff rates for the recent three years for every point in time.

2.2.2.3 Industry Level Measures: External Dependence, R&D and Resource Intensity

The measure for external dependence on finance, an industry variable, is taken from Beck (2003). This measure captures the extent of capital expenditures in an industry that were funded externally, i.e. not with internal funds, to the total capital expenditure. This measure is very common in the literature since Rajan and Zingales (1998), and is generally constructed using data on US firms over a 10 year average. The underlying assumption is that the extent of dependence on external finance is a technological matter and depends on the characteristics of the industry such as the size of the fixed costs, the lag between investment and profit materialization (which will require financing) and similar considerations. The measure is constructed using Compustat data on US firms. The reason for using US firms is that US is considered to be the most friction free economic environment and therefore therefore once the measure is computed for US firms it reflects mostly the characteristics of the

industry and not so much the restrictions of the economic environment.

The measure for intensity of R& D in industry level, is taken from Freitas (2004). The measure reflects the intensity of R& D activity taken within industry and is constructed using Compustat data on US firms, as the average of the ratio of the R& D expenditure to book value of the firms within and industry.

Several other industry level variables enter regression equation (1) in the interaction terms denoted by $\sum_k \delta_k X_{i,k} * Y_{j,k}$. These additional industry level variables, $Y_{j,k}$, are measures of resource intensity of the corresponding intensity, i.e. natural resource intensity, human capital intensity and capital intensity. Similar to measures of external dependence and R & D intensity, these measures are assumed to be inherent characteristics of various industries. For example, wood industries and petroleum industries have a high level of dependence on natural resources. These variables are included in the regression, in the interaction terms with the resource abundance in the country. To construct these measures, similar to the literature, e.g Freitas (2004), I have used the data for US firms over a ten year period of 1992-2001. Natural resource intensity is a dummy variable that takes a value of 1 for industries that are considered resource intensive including wood products, paper and products, petroleum refineries, miscellaneous petroleum and coal products, other nonmetallic mineral products, iron and steel and non-ferrous metals. Investment intensity is constructed as the median of the ratio of gross fixed capital

performance to value added among US firms over the period 1992-2001. The index for human capital intensity is the industry's mean wage over that of the whole manufacturing sector in the US. The required data to construct these variables is available in TPP database as well.

2.2.2.4 Country Level Measures: Financial Obstacles and Resource Endowments

The indicator on Financial Obstacles intends to capture the extent of financial obstacles faced by the firms. Equivalently, we make use of the inverse of an indicator used to capture the amount of financing available to the firms. This indicator, Private Credit to GDP, is a very common measure of financial development, and is defined as the amount of credit offered to firms by financial intermediaries divided by GDP. We will use inverse of this measure throughout the paper as the main measure of financial obstacles faced by firms.

Several other measures of financial development are common in the literature as well, such as market capitalization, which is defined by the size of stock market divided by GDP. As a robustness check, we will make use of this measure as well. However such measures, which depend on the stock market, do not directly capture the amount of funds available to firms, especially since stock prices reflect expectations about future growth and profitability.

Other country level variables that appear in regression (1) as in interaction terms $\sum_k \delta_k X_{i,k} * Y_{j,k}$ are measures of resource abundance at country

level. They include measures on factor endowment such as physical capital, human resource capital and natural resource capital. These measures are obtained from various sources. The measure of human capital endowment in a country is proxied by the average schooling, obtained from Barro and Lee (2000) database. The most up to date cross-country data is available for year 2000 and not 2001, however we notice that schooling varies extremely slowly and it is unlikely that using schooling as of year 2000 instead of 2001 will affect the analysis. The level of physical capital endowment, proxied by the level of physical capital per worker is taken from Penn World Tables. The endowment in natural resource are obtained from World Bank's Expanding the Measure of Wealth Database.

2.2.3 Results

The result of the basic regression (1) are reported in Table (2.4). The dependent variable are relative size of large to small firms in various points of the distribution. Our hypothesis expects us to see the coefficient on interaction of Trade Openness and Financial Obstacles to be positive and significant. As Table (2.4) shows this coefficient is positive and significant for three out of six of the disparity measures. The measures for which we do not see a significant coefficient are $P^{95/75}$, $P^{75/50}$ and $P^{50/25}$. These three ratios, compare the size of firms which are in various percentiles of the firm size distribution that are close to each other compared to the three other measures with significant coefficients. One reason to explain why the coefficients on these measures

are not significant, is that given that our firm size distribution is very crude. Basically, the firms in each industry have been grouped in 5 bins, therefore it very often happens that firms in say, 95th percentile and 75th percentile happen to be in the same bin, therefore for the corresponding industry $P^{95/75}$ will be equal to one. Therefore when comparing the size of firms in close percentiles, $P^{95/75}$ does not provide enough variation at all, and therefore we do not see any significant coefficient.

Ratios of firms in other points in firm size distribution have been used in the regression, such as $P^{98/95}$, $P^{80/75}$, $P^{80/20}$, and so on. The results are not reported in Table (2.4), but show a very similar pattern. For ratios such as $P^{98/95}$, $P^{80/75}$ we do not see much variation in the dependent variable and the coefficients are not significant, however for ratios on far-enough points of the distribution such as $P^{80/20}$ and $P^{70/20}$, the coefficients on the main interaction term are significant at at least 10 percent.

The two industry characteristics interaction with Financial Obstacles, namely External Dependence and R&D intensity do not appear significant in any of the regressions.

There are three interaction terms involving factor endowments out of which only the human capital factor appears to have significant second order effects. In all the regressions where the main interaction terms is significant, the human capital interaction also appears significant.

All the regressions include instrumental variables to control for reverse causality and simultaneity. The concern about reverse causality is that, it might be argued that instead of Financial Obstacles affecting disparity, it is disparity that is driving financial underdevelopment. It could be the case that, for example, in cases of extreme disparity in firm size, banks do not have incentive to improve their financial services to service smaller firms. To control for reverse causality and simultaneity, we instrument financial development/obstacles with Legal Origin. Countries in our sample have either British, French, German or Scandinavian legal origin (data is from La Porta, Lopez-de-Silanes, Shleifer and Vishny (1999)). Previous research has shown that the legal origin of a country influences its legal treatment of creditors and shareholders, its accounting standards and the efficiency of contract enforcement, and thus the quality of its financial services. While we cannot reject the possibility that there is a link from the structure of firm distribution to the financial sector, using the legal origin to extract the exogenous component of financial development allows us to conclude that the positive relationship is not merely due to reverse causality or simultaneity bias.

The results so far, indicate support for our hypothesis and they are not due to reverse causality and simultaneity. We also conduct further robustness analysis.

2.2.4 Robustness Analysis

One set of sensitivity analysis and robustness checks deals with alternative measures of explanatory variables. Now we discuss results that are run with other measures of tariffs, financial development and various proxies for financial development. In all of the following robustness analysis, the dependent variable is $P^{95/25}$.

In the basic regressions reported in Table (2.4), average simple tariff of the recent three years are used to construct measure of trade openness. The regressions are also run with other categories of tariffs. For example, import weighted tariffs (also from TPP database) and averages of import weighted tariffs for two or three lagged years. The results have been in most part similar to Table (2.4) and therefore are not repeated here [3]. The reason for similarity of results is that there is high correlation between various measures of tariffs as evidenced in Table (2.3).

Several robustness checks are conducted with respect to various measures and proxies of Financial Obstacles or alternatively financial development. In the original regressions, Private Credit to GDP has been used as a primary measure of financial development (and its inverse as measure of Financial Obstacles). Another common measures of financial development in the literature is the level of stock market capitalization to GDP (denoted by Market Cap).

[3]Results available upon request.

The regressions are run by including Market Capitalization alone as well as together with private credit to GDP. The results are reported in columns (2) and (3) of Table (2.5). The coefficient on interaction terms with Market Capitalization is significant at 10 percent in column (2), however when both private credit and market capitalization are included, market capitalization is not significant on its own. However its inclusion reduces significance of private credit to GDP coefficient to 15 percent.

One concern is that, the Private Credit variable may not picking up financial development but actually other aspects of development which happen to be highly correlated with Private Credit. To address this concern, several other measures of development such as a measure of Law and Order and also the level of GDP per capital as an overall measure of development are used in regressions instead of and together with Private Credit variable. The results are reported in columns (4)-(8). Similar to Market Capitalization, the interaction coefficient on measures are significant on its own, however when used together with Private Credit, the explanatory power of Private Credit is larger. The result in the last column contains all the variables, however none is identified perhaps due to high correlation of various measures of development and the small size of the sample that does not provide enough variation to distinguish between any of them.

One interesting observation is that in all except one of the specifications in Table (2.5), the coefficient on the human capital interaction remains signif-

icant at 5 percent. This seems to be signaling important channels of effects of human capital factors on distributional features of firm size, however this paper does not explore such aspects any deeper.

Another set of robustness analysis is conducted to further address the causality and simultaneity issue. We have already included an instrumental variable to address this issue, however several more direct tests are conducted which follow conceptually from the theoretical hypothesis. Our hypothesis focuses on an specific channel through which financial development affects firms, and that is in the context of heightened competition due to trade. Therefore it would be another confirmation for the hypothesis, if we observed stronger effects within high trade sectors. In order to explore this further, the sample of country-industry pairs are divided by two depending on whether the corresponding sector was among the sectors with higher or lower levels of trade. To capture high level of trade, we focused on three ratios, export to output, import to output and finally total trade as sum of export and import to output. Within each country, sectors are divided according to being above or below median with respect to each of these measures. The regressions are run for these subsamples and results are reported in Table (2.6). Consistent with our hypothesis, we see stronger effects in sectors with high exports and high trade. The result for high import are also more significant also only at 15 percent significance.

Overall, the robustness checks have provided further assurance about

validity of the hypothesis. Although the small sample size and the nature of the underlying database do not allow for more rigorous and refined analysis of the distribution with more refined measures of disparity, the results so far indicate an interesting and relatively robust relation/link along the lines of the proposed mechanism.

2.3 Firm Level Analysis: Firm's Decision to Upgrade Technology

This section provides some more analysis on the relation of firm's decision to upgrade, trade openness and financial development. In studying this relation, the paper has focuses on a specific mechanism to derive the hypothesis. The mechanism holds that in presence of high competition pressures from trade openness as frictions in access to finance, larger firms tend to be able to upgrade their technology more. The previous section has focused on analyzing the aggregate manifestation of this mechanism, namely the disparity in firm size distribution. However this mechanisms is in the first place a hypothesis at firm level, therefore it would be desirable to test its validity at the firm level. Moreover, it would be more desirable to perform the analysis in the context of less developed countries that have lower levels of financial developments. This section intends to do that.

This section makes use of a relatively new cross country survey on firms characteristics, statistics, decisions and the obstacles they face in the economic environment. The Enterprise Survey is conducted by the World Bank in a large

number of emerging and developing counties since 2000 and includes 100,000+ firms in 122 countries. The data has been collected gradually across years form various countries and includes many small and/or developing countries from various regions such as central Asia and eastern Europe that usually are not present in commercially available data.

The Enterprise Survey data and the Business Size Class data each have specific characteristics which make each of them suitable for one kind of the two different tests that are addressed in this paper, together providing a picture at both the firm level and distribution level. The advantage of Enterprise Survey is that it provides data on small and developing countries which are most relevant to an study about financial development. Moreover Enterprise Survey provides data on firm level decisions which makes it possible to directly test the mechanism proposed in the paper and discussed in the following subsections. However there are some disadvantages as well. For example due to the very nature of any survey data, the dataset comprises of the answers provided by the firms and therefore contains some elements of subjectivity. Moreover, even though the sample of firms in the survey is chosen to mimic the the real distribution of firms within each country, the survey does not have enough firms in each industry to enable us to analyze the disparities in firm size distribution. As such, the Business Size Class is the more appropriate database for testing disparity in firm size distribution.

The next subsections discuss the empirical strategy, the data and re-

sults.

2.3.1 Empirical Strategy: Firm Level Analysis

The outcome variable x_{fij} is the binary value indicating whether the firm has upgraded its technology in the last three years and the regression is basically a probit estimation. The test is for how outcome variable varies by firm size and across countries with different openness and financial development. Since we are interested in how the effect of openness varies by financial development and firm size, we allow the coefficient on openness to vary by financial development and firm size.

Key terms of interest are interaction effects of openness and financial development; and of firm size, openness and financial development. The former is a level effect moderated by the latter size-dependent effect. The basic regression specification is

$$x_{fij} = \beta_1 TO_{ij} * FINDEV_j + \beta_2 TO_{ij} * FINDEV_j * Size_{fij} \tag{2.2}$$
$$+ \alpha_0 + \alpha_1 * size_{fij} + \alpha_2 * TO_{ij} + \sum \gamma_j * C_j + \sum \gamma_i * I_i + + \epsilon_{fij}$$

The outcome variable x_{fij} is a binary value indicating whether the firm f from country j and industry i has upgraded its technology in the last three years. Here TO_{ji} and $FINDEV_j$ measure trade openness and financial

development of country j and industry i. Country and industry dummies are included.

The main coefficients of interest are β_1 and β_2. Coefficient β_1 captures the average interaction effect of trade openness and financial development. A positive β_1 indicates that increasing trade openness leads to more technology improvement when financial institutions are more advanced. The hypothesis for β_2 is that it should be negative, implying that as access to financial services improve, the probability of technology upgrade increases for smaller firms, and the effect is more pronounced in countries with higher trade openness. These are what our hypothesis lead us to expect.

2.3.2 Data

The paper uses the Enterprise Survey conducted in 2003 and 2005 in 100+ countries. Since we needed to augment this data with tariff data (from TPP database), we dropped countries for which we did not have tariff data at industry level. This reduced the number of countries to 58 countries from which around 21,000 firms in manufacturing sector are included in the regressions.

The survey is a long questionnaire covering firm information, actions and firms perception of business environment. The firm-related questions cover general information about the firms, including the sector, industry, ownership by government or foreigners, number of permanent and temporary employees,

wages, sales, growth of sales. In addition the survey asks qualitative questions about the actions of the firms in recent years, such as whether they have upgraded their technology in order to reduce costs and whether they have initiated new products. The survey also provides various qualitative questions on the perception of the firm about the business constraints such as financial services, infrastructure deficiencies , corruption and such.

For the variable, x_{fij} in the regression, we make use of one of questions in the survey that asks the firms whether they have upgraded their technology in the last three years. For firm's size, we use the number of permanent employees. In some variations of the regressions, we use the number of permanent workers divided by the average number of employees in the sector. We also include the size of the firm and some other firm characteristics directly in the regressions. These include foreign ownership dummy and government ownership as these variables are likely to have an effect on the ability of the firm to access finance and/or new technologies.

The sources of data for trade openness and country level variables such as financial development are similar to the previous section; These are obtained from TPP database, World Development Indicators and Penn World Tables.

2.3.3 Results

The results of basic regression (2.2) on the probability of firm technology upgrade are reported in Table (2.7), column (3). The result confirms

the prediction of a positive level effect and a negative slope effect for the interaction effects. The results also point to the significance of the coefficient on size of the firms. In order to make sure the coefficient on the triple interaction term TO*FINDEV*log(employment) is not driven simply because of log(employment), two first columns in Table (2.7) show the effect of each term alone. Even though size seems to be a very strong predictor of the outcome variable, the first two columns indicate that the interaction term TO*FINDEV is playing a role as well.

In some specifications of the regressions, other characteristics such as foreign and government ownership are included. Column (4) shows that the coefficient on foreign ownership is not significant. The reason could be that foreign firms might be generally more technologically advanced and therefore we might not see a lot of upgrades in these firms. Another reason could be in our sample foreign firms are generally larger than domestic firms, therefore effect of foreign ownership dummy is likely to be picked up by the size dummy. Another firm size variable included is the government ownership which appears negative and significant. The reason to include government ownership was the possibility that government ownership helps the firms to access finance through local state banks and directed government loans, therefore this might be a critical variable in probability of technology upgrade especially in developing world. However the coefficient appears negative. The reason could be that other factors are at play as well, for example the smaller need of government-owned firms to upgrade their technology since due to government support they

are less concerned about improving efficiency and remaining competitive. In some specifications, we made use of other firm level variables available in the survey, however they are not reported in the table due to reasons explained shortly. For example, the survey includes questions on the number of competitors a firm has, whether the elasticity of their product to a %10 increase in price is low or high, what percentage of their customers would switch away from them if they raised the price by %10. These question provide information about the level of competition in the industry and the incentives of the firm for technology upgrade, so the potentially are good candidates for inclusion in the regressions. However the coverage of these variables is very poor and including them reduces the sample size in some country-industry pairs drastically to a point which makes cross country-cross industry comparison less reliable.

Table (**??**) also provides the results of regressions on several subsamples. The results for a sample of domestic firms only is similar to the overall sample results, this is not surprising as the foreign ownership dummy was also non significant as explained above. As the size appears an important variable, Column (6) provides results for a subsample of smaller firms, those that are smaller than the median in the corresponding country-industry pair. It is interesting that the coefficient on the interaction term with size is smaller(in absolute value) and less significant now, and the coefficient on the standalone size variable is larger. This means the importance of size is more pronounced within smaller firms. The results for exporters is surprising. The presupposition was an exception of having larger and more significant results for

this subsample. This might be meaning that effects of tariff, trade and size influence the whole industry whether or not a firm is a exporter. Another explanation could be that exporters are in general larger (in our database, they are about 4 times larger than non-exporters), therefore the effect of size within their subsample is already taken into account. The comparison of small firms and exporter subsamples is interesting and points to the pattern that effect of size in our regression are better identified within samples of smaller firms.

Finally the last column, sheds some light on the issue that whether FINDEV is identifying financial development or the general development of the country. To address this, last column reports the results for a regression which includes GDP per capita as a proxy for general development of a country. Though significant, their effect is much smaller compared to coefficients on FINDEV and does not reduce the significance of FINDEV interactions.

2.4 Conclusion

This paper provides empirical evidence that is consistent with financial development having a differential impact across firms within an industry. I find that financial obstacles increase the firm size inequality and the effects are more pronounced in country-industries with more trade openness. Also the paper detects that in addition to the overall effects, financial development has a differential impact on firms according to their size and increases the chance of technology upgrades for smaller firms more than it does for larger firms, again these effects are more pronounced in presence of increased competition

due to trade openness.

By focusing on the changes in relative size of firms, this paper points to the reallocation of resources within industry due to financial development and trade. This raises an interesting question for further studies that how these reallocations affect the overall productivity of the sector.

Table 2.1: List of Countries in the Empirical Analysis of Chapter 2

Distribution Disparity Analysis	Firm Level Analysis	
Austria	Albany	Lithuania
Belgium	Armenia	Latvia
Czech	Azerbaijan	Morocco
Denmark	Benin	Moldova
Finland	BGR	Madagascar
France	Bosnia	Macedonia
Germany	Belarus	Mali
Hungary	Brazil	Mauritius
Ireland	Chile	Malawi
Italy	China	Nicaragua
Japan	Costa Rica	Oman
Korea	Czech Republic	Philippines
Netherlands	Ecuador	Poland
New Zealand	Egypt	Portugal
Portugal	Spain	Romania
Slovak Republic	Estonia	Russia
Spain	Georgia	El Salvador
Sweden	Greece	Slovakia
Switzerland	Guatemala	Slovenia
Turkey	Guyana	Syria
United Kingdom	Honduras	Thailand
	Croatia	Tajikistan
	Hungary	Turkey
	Indonesia	Tanzania
	Ireland	Ukraine
	Kazakhstan	Vietnam
	Kyrgyzstan	South Africa
	Cambodia	Zambia

Table 2.2: Correlations between Measures of Disparity in Firm Size Distribution

	$P^{95/75}$	$P^{95/50}$	$P^{95/25}$	$P^{75/50}$	$P^{75/25}$	$P^{50/25}$
$P^{95/75}$	1					
$P^{95/50}$	0.7043*	1				
$P^{95/25}$	0.6628*	0.9354*	1			
$P^{75/50}$	−0.0208	0.2665*	0.2666*	1		
$P^{75/25}$	0.0379*	0.1017*	0.2893*	0.6078*	1	
$P^{50/25}$	−0.03747	−0.0317*	0.1497*	−0.0173	0.4177*	1

Table 2.3: Correlations between Measures of Tariffs

	Simple tariff	Simple tariff (t-1)	Simple tariff (t-2)	Weighted tariff	Weighted tariff (t-1)	Weighted tariff (t-2)
Simple tariff	1					
Simple tariff (t-1)	0.9194	1				
Simple tariff (t-2)	0.8603	0.9071	1			
Weighted tariff	0.9397	0.8792	0.8271	1		
Weighted tariff (t-1)	0.8642	0.9333	0.8595	0.9203	1	
Weighted tariff (t-2)	0.7993	0.8494	0.9281	0.8573	0.9007	1

Tariff data is from Trade, Production and Protection database, Nicita and Olagarreaga (2001)

Table 2.4: Disparity in Firm Size Distribution

VARIABLES	(1) $P^{95/25}$	(2) $P^{95/75}$	(3) $P^{95/50}$	(4) $P^{75/50}$	(5) $P^{75/25}$	(6) $P^{50/25}$
$TO * FINOBST$	299.45*	81.08	254.56*	8.46	14.75**	0.59
	(0.082)	(0.133)	(0.095)	(0.130)	(0.050)	(0.688)
K	88.38	45.07	168.56	5.43	-0.10	-2.47
	(0.566)	(0.288)	(0.278)	(0.745)	(0.995)	(0.135)
N	18,155.74	7,682.53	9,896.54	-4,393.94	-4,240.49	88.89
	(0.642)	(0.423)	(0.799)	(0.359)	(0.345)	(0.856)
H	717.00**	62.74	258.91*	15.22	40.27*	1.26
	(0.036)	(0.169)	(0.099)	(0.433)	(0.086)	(0.732)
$EXT * FINOBST$	-862.50	837.64	1,755.59	-67.66	-289.48	-42.90
	(0.854)	(0.428)	(0.559)	(0.759)	(0.398)	(0.370)
$RD * FINOBST$	dropped	566.57	-22,371.45	-3,904.15	-2,972.10	309.20
		(0.971)	(0.534)	(0.185)	(0.445)	(0.586)
Observations	239	239	239	239	239	239
Adjusted R-squared	0.287	0.365	0.248	0.076	0.296	0.325

Note. P-values from heteroskedasticty robust standard errors are reported in parentheses.
Significance at 1%, 5% and 10% are denoted by ***, ** and *.
All regressions include country and industry dummies.
All regressions include interaction of legal origin and TO as Instrumental Variables.

TO= Measure of trade openness, 100- simple tariff averaged over 3 years
$FINOBST$= Measure Financial Obstacles. Inverse of Private Credit to GDP
EXT= Measure of dependence on external finance
RD= Measure R&D intensity
K= Country Capital Stock per worker * Capital Intensity of the Industry
N= Country Natural Resource per capita * Natural Resource Intensity of the Industry
K= Schooling * Human Capital Intensity of the Industry

Table 2.5: Disparity in Firm Size Distribution, Robustness Checks with Various Proxies

VARIABLES	(1) P95/25	(2) P95/25	(3) P95/25	(4) P95/25	(5) P95/25	(6) P95/25	(7) P95/25	(8) P95/25
$TO * (PrivCredit)^{(-1)}$	282.65*		296.56†		309.72		268.97†	279.59
	(0.080)		(0.128)		(0.117)		(0.141)	(0.312)
K	8.40	-5.05	8.52	1.48	8.68	-1.91	8.15	7.74
	(0.587)	(0.976)	(0.577)	(0.497)	(0.576)	(0.910)	(0.604)	(0.617)
N	16,105.88	-7,650.43	16,009.03	-5,816.75	16,193.02	-13,206.08	15,870.28	14,717.36
	(0.672)	(0.861)	(0.674)	(0.897)	(0.671)	(0.765)	(0.682)	(0.708)
H	712.35**	572.44	713.53**	654.75*	699.98**	683.39*	717.51**	724.35**
	(0.035)	(0.101)	(0.035)	(0.066)	(0.040)	(0.057)	(0.048)	(0.050)
$TO * (\text{ Mkt Cap})^{(-1)}$		157.34*	60.88					134.73
		(0.094)	(0.925)					(0.851)
$TO * (\text{Law \& Order})^{(-1)}$				-76.77*	17.80			27.82
				(0.053)	(0.662)			(0.569)
$TO * (\text{GDP per capita})^{(-1)}$						59,521.65*	3,204.75	17,824.75
						(0.079)	(0.937)	(0.727)
Observations	239	280	239	280	239	280	239	239
Adjusted R-squared	0.296	0.254	0.292	0.242	0.292	0.254	0.292	0.283

Note. P-values from heteroskedasticty robust standard errors are reported in parentheses.
Significance at 15% is denoted by †. Significance at 1%, 5% and 10% are denoted by ***, ** and *.
All regressions include country and industry dummies and Legal Origin as instrumental variable.
TO= Measure of trade openness, 100- simple tariff averaged over 3 years
Mkt Cap, Law & Order, GDP per capita are used as various proxies for (financial) development.
K, H, N are interactions of country factor endowment and industry factor intensity.

Table 2.6: Disparity in Firm Size Distributions, Robustness Checks in Subsamples

VARIABLES	(1) High Import	(2) Low Import	(3) High Export	(4) Low Export	(5) High Trade	(6) Low Trade
$TO * FINOBST$	207.33	533.04	1,462.01**	-157.91	623.31**	-262.73
	(0.127)	(0.204)	(0.013)	(0.301)	(0.013)	(0.289)
K	89.94	1.20	-20.98	-1.42	-18.64	16.64
	(0.592)	(0.370)	(0.410)	(0.379)	(0.467)	(0.614)
N	843.16	-29,179.94	24,847.91	-112,679.63	74,489.96	19,076.17
	(0.982)	(0.266)	(0.631)	(0.364)	(0.211)	(0.583)
H	575.00	73.95	975.84**	-439.45	911.25**	169.31
	(0.144)	(0.630)	(0.025)	(0.392)	(0.034)	(0.378)
$EXT * FINOBST$	2,547.68	3,301.03	3,562.06	2,367.85	-826.30	-2,796.63
	(0.744)	(0.192)	(0.679)	(0.464)	(0.918)	(0.290)
$RD * FINOBST$	-31,005.59	-123,491.63	-170,145.12	128,420.61	-69,671.62	164,974.10
	(0.720)	(0.324)	(0.141)	(0.283)	(0.432)	(0.265)
Observations	130	109	130	109	130	109
Adjusted R-squared	0.425	0.611	0.261	0.976	0.248	0.981

Note. P-values from heteroskedasticty robust standard errors are reported in parentheses.
Significance at 1%, 5% and 10% are denoted by ***, ** and *.
All regressions include country and industry dummies and Legal Origin as instrumental variable.
TO= Measure of trade openness, 100- simple tariff averaged over 3 years
K, H, N are interactions of country factor endowment and industry factor intensity.

Subsample regressions:
High (Low) Import= sectors with import/output higher (lower) than median
High (Low) Export= sectors with export/output higher (lower) than median
High (Low) Trade= sectors with (export+import)/output higher (lower) than median

Table 2.7: Firm Level Analysis, Results and Robustness

VARIABLES	(1) uptech	(2) uptech	(3) uptech	(4) uptech	(5) Domestic Firms	(6) Small Firms	(7) Exporter Only	(8) GDP
log(employment)	1853***	1914***	1452***	1503***	1581***	2293***	714***	1433***
	(0.007)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)
TO* FINDEV		166***	122***	123***	106***	153***	102*	139***
		(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.069)	(0.000)
TO*FINDEV			- 11***	-11***	-10***	-8 **	-15***	- 16***
*log(employment)			(0.000)	(0.000)	(0.000)	(0.016)	(0.002)	(0.000)
Foreign ownership				-169				
				(0.581)				
Govt Dummy				-112***				
				(0.001)				
TO* GDP per capita								-0
								(0.329)
TO* GDP per capita								-0***
*log(employment)								(0.001)
Observations	21217	20792	20792	20771	17940	10477	6101	20792
R-squared	0.1373	0.1389	0.1398	0.1404	0.1470	0.1414	0.0803	0.1403

Note. P-values from heteroskedasticty robust standard errors are reported in parentheses.
Significance at 1%, 5% and 10% are denoted by ***, ** and *.
Coefficients are multiplied by 10000 for ease of presentation.
All regressions include country and industry dummies.
TO= Measure of trade openness, 100- simple tariff averaged over 3 years
FINDEV= Measure of financial development, private credit to gdp averaged over 3 years
Small firms are those smaller than median in each country-industry

Table 2.8: ISIC codes

ISIC 2	ISIC 3	ISIC 2 Description
311-312	151, 152, 153, 154	Food Products
313	155	Beverages
314	160 (16)	Tobacco
321	171, 172,173 (17)	Textiles
322	181,182	Apparel, except footware
323	191	Leather products except footware and apparel
324	192	Manufacture of footware, except rubber or plastic
331	201,202 (20)	Wood products except furniture
332	361, 202	Furniture except metal
341	210 (21)	Paper and paper products
342	221,222,223 (22)	Printing and publishing
351	233,241,242	Industrial chemicals
352	242	Other chemicals
353	232	Petrolum refineries
354	231,232, 269	Misc. products of petrolum and coal
355	251	Rubber products
356	252	Plastic products n.e.c.
361	269	Pottery, china and earthenware
362	261,332	Glass and glass products
369	269	Other non-metallic mineral products
371	271	Iron and steel industries
372	272	Non-ferrous metal industries
381	281, 289	Fabricated metal product
382	289, 291,292,300	Machinery except electrical
383	293,311,312,313,315,319,321,322,323,331	Electrical machinery
384	341,342,343 (34), 351,352,353,354,359 (35)	Transport equipment
385	331,332, 333	Professional and scientific
390	369	Other manufacturing

Chapter 3

Terms of Trade in the North-South Trade

3.1 Introduction

This paper aims to investigate a long held view on the deterioration of terms of trade in North-South trade. It has been widely argued in the past by academics and policy makers in low income countries that as the world grows, demand shifts away from the south that specializes in low income elasticity goods and towards the north. As such industrial policy advocates generally suggest that a developing country needs to transform the composition of its production towards goods with higher income elasticities to enjoy benefits of world growth, see Evans (1987).

To investigate this issue, a simple version of a Ricardian model of trade is used as the basis for a simulation exercise. Original Ricardian models have homothetic preferences and therefore are not proper vehicles to address issues related to asymmetry in the specialization of goods with respect to their income elasticity. However several variations of Ricardian models with non-homothetic preferences exist which are proper tools in the North-South trade context. This paper develops a numerical simulation exercise based on one of such papers by by Matsuyama (2000).

The model is a version of static Ricardian model with a continuum of goods and unit demand non-homothetic preferences. In this model one country (south) has comparative advantage in production of goods with lower income elasticity of demand. One prediction of this model is that due to a uniform global improvement in technology, i.e. smaller unit labor requirements, the terms of trade moves against south.

To test this prediction, I will have a selection of south and north countries. I will model the unit labor requirements stochastically and calibrate the parameters of the model to trade and production moments for a steady state equilibrium in the past, say time t_0. To investigate the implications of world growth on the terms of trade and welfare, I will calculate the equilibrium at a later time, say time t_1 by introducing a %50 global improvement in unit labor requirements in the calibrated model. I will simulate the model at time t_1 for 1000 times and compare the average of terms of trade at t_1 with that of t_0.

My result provides some support on the accuracy of the prediction using a model-based numerical exercise.

3.2 Model

The numerical exercise is based on a variation of Ricardian model of trade as developed in Matsuyama (2000). Similar to the classic Ricardian model, trade takes place due to technological differences however contrary to the classic model, the agents have non-homothetic preferences. There is a continuum of competitive industries, indexed by $z \in [0, \infty)$. The unit labor

requirements in home and foreign country are denoted by $a(z)$ and $a^*(z)$ respectively. We assume $\frac{a^*(z)}{a(z)}$ is strictly decreasing, meaning home's comparative advantage in low indexes. If we normalize wage in foreign country to 1, and denote wage at home by w, then pattern of specialization is given by

$$\begin{aligned} p(z) &= wa(z), \quad z \in [0, m] \\ p(z) &= a^*(z), \quad z \in [m, \infty) \end{aligned}$$

where m, the marginal good is given by

$$w = \frac{a^*(m)}{a(m)}. \tag{3.1}$$

The population in home and foreign is given by N and N^*. Consumers may have different skills given by distributions $F(h)$ and $F(h^*)$. A home agent with skill h earns wh and a foreign agents with skill h^* earns h^*. Each consumer with income I faces the utility maximization problem of

$$\begin{aligned} \max_{x(z)} & \int_0^\infty b(z)x(z)dz \\ \text{s.t.} & \int_0^\infty p(z)x(z)dz \leq I \\ & b(z) > 0 \\ & x(z) \in \{0, 1\}. \end{aligned}$$

Another assumption determines the specializations based on income elasticities. Assume $\frac{b(z)}{a(z)}$ and $\frac{b(z)}{a^*(z)}$ are decreasing. Then

$$\frac{b(z)}{p(z)} = \frac{b(z)}{\min\{wa(z), a^*(z)\}}$$

will be decreasing. This determines the order that households purchase goods, and due to this specification, this order will be the same as that of home's comparative advantage.

Each household with income I starts buying goods in the order they are indexed until he exhausts all of his money. In particular, the household in the South with skill h buys goods in $[0, u(h)]$ s.t.

$$\underbrace{E(u(h))}_{\text{expenditure on } [0,u(h)]} = \int_0^{u(h)} \underbrace{\min\{wa(z), a^*(z)\}}_{p(z)} x(z)dz = wh$$

Model is closed by the balanced trade equation:

$$\underbrace{N\int_0^{\infty} \max\{h - \int_0^m a(s)ds, 0\}dF(h)}_{\text{value of home imports}} = \underbrace{N^*\int_0^{\infty} \min\{\frac{h^*}{w}, \int_0^m a(s)ds\}dF^*(h^*)}_{\text{value of home exports}} \tag{3.2}$$

Equations (3.1) and (3.2) pin down the equilibrium values of m, w and hence the equilibrium itself. In the case of homogeneous agents, there will be cutoffs $m < u < u^*$ where the following patterns of consumption and production materialize: goods in $[0, m]$ are produced by south and consumed by both the north and the south; goods in $[m, u]$ are produced by the north and consumed by both countries; goods in $[u, u^*]$ are produced in north and consumed by the north only, and finally goods in (u^*, ∞) are not produced.

The equilibrium characterization in this model is pinned down by some cutoff points due to the special ordering of the goods. The model imposes

two orderings on goods, by comparative advantage and elasticities, namely decreasing functions of $\frac{a^*(z)}{a(z)}$, $\frac{b(z)}{a(z)}$ and $\frac{b(z)}{a^*(z)}$

To examine the effects of technology improvement, Matsuyama (2000) performs a comparative analysis by assuming the rate of technology improvement to be given by

$$\frac{da(z)}{a(z)} = -g(z) \text{ and } \frac{da^*(z)}{a^*(z)} = -g^*(z)$$

with positive $g(z)$ meaning technology improvement. By differentiating the equilibrium equations (3.1) and (3.2) it can be shown that in case of uniform improvement, i.e. $g(z) = g^*(z) = k$, the terms of trade, w, moves against the south. The idea is that improvement in technology leads to higher income for north; Due to unit demand for goods, this does not create more demand for southern goods and shifts the demand to rather higher indexed goods. Moreover with lower unit labor requirements, for south to clear its labor markets it expands range of its produced goods to the ones with less comparative advantage and this lowers its terms of trade further more.

In the next section, I develop a strategy to numerically test the mechanism and the predictions of the model described above.

3.3 Testing the Model

In this section I will first explain the choice of countries and will explain why they could be considered as good candidates representing the south and

north countries, specifically with respect to the strong assumption imposed on their pattern of specialization. Then I will describe the algorithm developed to test the predictions and then the results are reported.

3.3.1 Choice of Countries

In the model, south will specialize in producing goods with low income elasticity, goods which each consumer starts off by consuming one unit and then moving on to higher indexed goods representing more luxurious goods as the income increases.

The commodity producing countries can be good candidates as southern countries producing low income elasticity goods. The only problem with that can be the argument that some commodities like oil do not satisfy the unit demand preference condition. However it should be noted that even though, oil itself may not fall into that category, many oil producing countries do not produce high-tech and luxurious goods and do not have strong medium or high-tech industries. Therefore, I hold that commodity producing countries, especially oil producing counties can be good candidates representing the south country in the model if we exclude the oil from their economy. As such, I will use oil producing countries as the south and the OECD countries as north. At this stage, the paper has only focused on Iran (oil excluded) as the south county versus OECD- excluding Belgium, Luxembourg, Czech, Slovakia and Poland due to lack of data for these countries before 1980's.

For comparative analysis, I will look at two time snapshots: averages of years 1970-1977 and years 1997-2003. The choice is due to availability of trade data for Iran. The test involves assuming a %50 global technology improvement at time t_1 with respect to the same pattern of comparative advantage at time t_0. Assuming same pattern of comparative advantage over such a long period of time may seem a strong assumption, however examining trade patterns provides support for this assumption. The composition and magnitude of top non-oil export items of Iran, shows that we can assume south (Iran) has not gained significant comparative advantage in other industries over time. Figures (3.1) and (3.2) show the same 4-digit SITC codes that comprise a largest part of Iran's non oil export over the two time periods. Moreover figures (3.3) and (3.4) show that oil still keeps a significant share in Iran's export. I conclude, that doing a comparative analysis over the mentioned two time period, keeping everything fixed except a %50 improvement on same relative advantages between Iran and OECD constitute a reasonable assumption.

3.3.2 Algorithm

While the equilibrium of the model and production patterns are easily described by two equations (3.1) and (3.2), it is hard to apply this ordering of goods to data. The model imposes two orderings on goods, by comparative advantage and elasticities, namely decreasing property of functions $\frac{a^*(z)}{a(z)}$, $\frac{b(z)}{a(z)}$ and $\frac{b(z)}{a^*(z)}$. Even though this makes the analytical characterizations easy, it is empirically hard to estimate the unit cost requirement as well as the function

$b(z)$. Moreover there is no chance that they have any monotonicity patterns similar to the model.

I will take an approach similar to Kehoe and Ruhl (2002) method of estimating a Ricardian model. I will treat $a(z), a^*(z)$ and $b(z)$ as random variables. To discretize the goods space, I consider goods indexed by $i = 1, 2, 3, ...$In equilibrium the number of goods will be determined endogenously.

Since the number of consumed goods is endogenous, to prevent it from getting too large and computationally problematic, I incorporate a variable $J = 100$ in the distribution of $a^*(i)$, I assume $\log a^*(i)$ is distributed uniformly in $[-1 + \log \frac{1}{J}, 1 + \log \frac{1}{J}]$. Hence on average $\log\, a^*$ equals $\log \frac{1}{J}$ and approximately on average a^* is bounded by a multiple of $\frac{1}{J}$. In other words, the north country consumer can at most consume a multiple of $J = 100$ northern goods . Throughout the simulations, the northern consumers at most consumed a total of 500 goods. In the program I draw the variables for 1000 goods, meaning the possibility of production of 1000 goods in the the world economy but this limit never was reached.

To allow for absolute advantage, I assume $\log(\frac{a(i)}{a^*(i)})$ is distributed uniformly in $[-1 + \beta, 1 + \beta]$.

$$\log(\frac{a(i)}{a^*(i)}) \sim U[-1 + \beta, 1 + \beta]$$

hence on average $\log(\frac{a(i)}{a^*(i)})$ equals β. In case $\beta = 0$, countries on average have similar technologies, and for $\beta > 0$, on average north has absolute advantage.

To model $b(z)$, I assume it is a uniform distribution in $[0,1]$ and negatively correlated with $\log(\frac{a(i)}{a^*(i)})$ with a parameter $-\rho$. This correlation is used to capture the property of the model, that south has comparative advantage in goods with low income elasticities, those which everybody consumes for sure.[1]

Constructing draws for $a(i)$, $a^*(i), b(i)$ based on above specifications, given any w, the prices of goods are determined by the costs associated with it, i.e. $p(i) = \min\{wa(i), a^*(i)\}$. Then $\frac{b(i)}{p(i)}$ are decreasingly ordered and consumers of each country consume one unit of the goods in such order as far as their total income allows. This income for home country is w and for foreign is 1. The program will search over values of w to find the one that satisfies the balanced budget equation.

To determine the parameters β and ρ, two model moments will be matched with the data moments , those are ratio of exports to production for south and ratio of two countries productions. The relative size of countries N and N^* is an average of two countries labor force populations over the period 1970-1977. The program searches over a range of $\beta \in [0, \infty)$ (practically $\beta \in [0, 3]$) and $\rho \in [0, 1]$ to find β^* and ρ^* that match the above moments to those of data in years 1970-1977.

[1]To create correlated uniform random variables in Matlab, I used Matlab function mvnrnd to create standard normal random variables x, y with correlation ρ. Applying the cdf of standard normal Ψ, we get uniform random variables $\Psi(x)$ and $\Psi(y)$. The correlation of $\Psi(x)$ and $\Psi(y)$ is not exactly ρ but is an increasing function of ρ and that is enough for the purpose here.

After finding β^* and ρ^*, I perform a comparative analysis. Within two time periods 1970-1979 and 1997-2003 the average gross output per worker has raised to 1.5 fold for the total economies considered here. I simulate the model, by drawing a, a^* and b from the above distributions with parameters β^* and ρ^*, however after that, I scale the unit labor requirements a and a^* by 1.5 to simulate the results of a %50 technology improvement. I draw 1000 different realizations of the economy. I calculate the equilibrium in each case and average over the terms of trade. Results are reported in next subsection.

For this exercise, I have used gross output as a measure of production instead of GDP. The reason is that export data is reported in total value rather than value added. Moreover, as explained in previous subsection, I have excluded the oil production from the gross output for Iran. Also the exports of both Iran and OECD counties to other countries are excluded from their gross outputs for the purpose of this exercise.

Bilateral trade data (SITC.Rev1) is taken from the united nation's statistical division's Comtrade database . However detailed trade data for Iran is not available for years 1978-1996 and that is the reason for the choice of specific time intervals in this paper.

The data on gross output for OECD countries is taken from OECD's STAN database. For a number of countries that were not members of OECD before 1980's, the series was interpolated backwards to obtain missing points.

The production data for Iran is taken from the Iranian national statistical center.

3.3.3 Results

Results of the calibration of the model to 1970-1977 moments as well as simulation for 1997-2003 are summarized in the following table.

The calibrated model behaves poorly in fitting the ratio of export to gross output and ratio of gross outputs. However the model performs well in capturing the size and direction of terms of trade movement in data even though that moment was not tried to be matched. One reason of the failure of the model in matching the output and export moments, can be the relative small size of Iran(without oil) versus the OECD countries. The reduction of terms of trade, predicted by the model can be seen in this version of estimating his model.

Table 3.1: Results, North-South Trade

	1970-1977		1997-2003	
	Model	Data	Model	Data
Terms of Trade	0.120	0.103	0.110	0.100
Ratio of per capita export	4.3	7.8	6.1	9.8
Ratio of export/output for south	0.02	0.001	0.03	0.004
utility north/south	1.3		1.4	

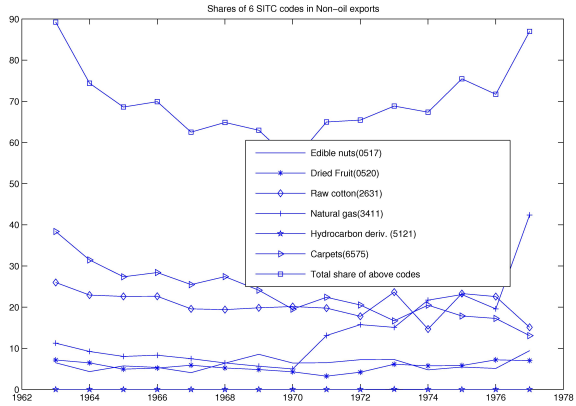

Figure 3.1: Iran: Share of 6 Top Codes in Non Oil Exports 1963-1977

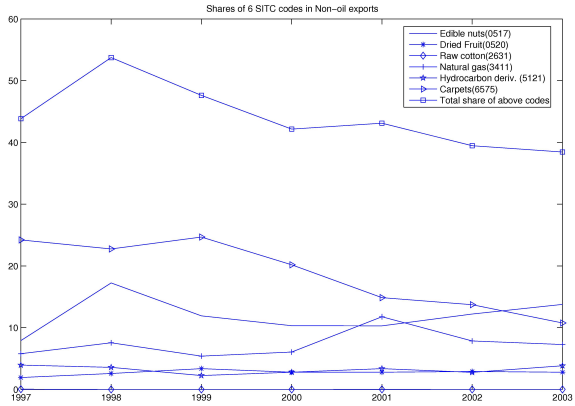

Figure 3.2: Iran: Share of 6 Top Codes in Non Oil Exports 1997-2003

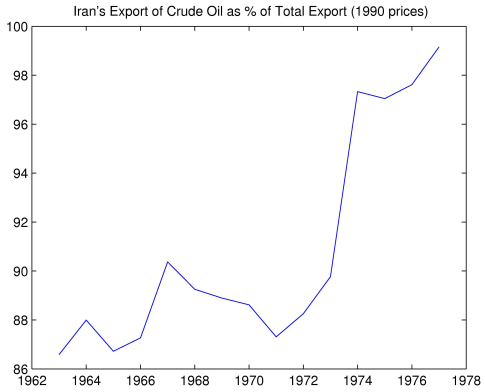

Figure 3.3: Iran: Share of Oil in Exports 1963-1977

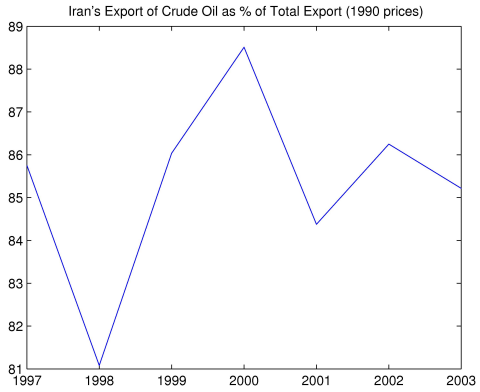

Figure 3.4: Iran: Share of Oil in Exports 1997-2003

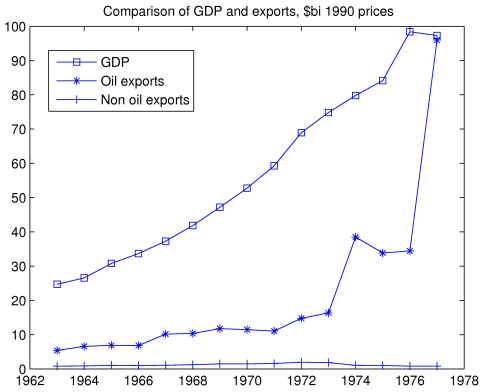

Figure 3.5: Iran: GDP and Oil Production 1963-1977

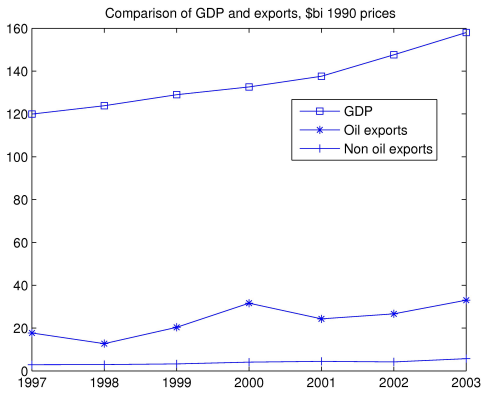

Figure 3.6: Iran: GDP and Oil Production 1997-2003

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This dissertation was typeset with LaTeX[†] by the author.

[†]LaTeX is a document preparation system developed by Leslie Lamport as a special version of Donald Knuth's TeX Program.